Locating Real-time Location of Perak Transit Buses and Determining its Estimation of Time of Arrival (ETA) at a Particular Bus Stop through the Development of Mobile Application on Android Platform

By

Wan Afifi Zawawie bin Wan Zakaria
16543

A dissertation submitted to the
Business Information System Programme
Universiti Teknologi PETRONAS (UTP)

In partial fulfilment of the requirements for the
BACHELOR OF TECHNOLOGY (Hons.)
(BUSINESS INFORMATION SYSTEM)

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATE OF APPROVAL

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Approved by:

Dr Noreen Izza binti Arshad
Supervisor
Computer & Information Science Department

UNIVERSITI TEKNOLOGI PETRONAS

MAY 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgement, and that the original work contained in this report have not been undertaken or done by unspecified sources or individuals.

(WAN AFIFI ZAWAWIE BIN WAN ZAKARIA)

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List of Abbreviations & Glossary

API	Application programme interface
Conspectus	Summary or overview of a subject or topic or matter
DFD	Data flow diagram
ETA	Estimation of time of arrival of the bus to a particular stop or station
FYP1	Final year project 1
FYP2	Final year project 2
GPS	Global positioning system (tracking system)
GUI	Graphical user interface
myPerakTransit	The mobile application that enables users to track the real-time location of Perak Transit buses and provide estimation of arrival time at a particular bus stop
OS	Operating system
Perak Transit	One of the major public bus service providers in Perak
RFID	Radio frequency identification (tracking system)
RTLS	Real-time location system (tracking system)
SDLC	System development life cycle
Supervisor	Assigned lecturer(s) to supervise the progress and quality of, the research and the development works of the prototype and the end-product

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Abstract

The main objective of this project is to develop a mobile application as an alternative to empower the current passengers and prospective users of Perak Transit buses. The mobile application will be known as 'myPerakTransit' is designed and developed to enable users to track the real-time location of Perak Transit buses and providing them with the estimation of arrival time of a particular bus to reach a specific bus station. Although there are many applications and of similar nature, this project differentiates from others through additional features that facilitate for the users of the Perak Transit buses in making informed travelling decision.

The project will be developed using Rapid Application Development (RAD) method through the use of prototyping and utilize the GPS technology to track the location of the buses. This paper consists of five (5) chapters: Introduction, Literature Review, Methodology, Results and Discussions, and Conclusion and Recommendations for 'myPerakTransit'.

Through the use of technology and mobile application, the project aims to tackle the issues pertaining to mobility, efficiency, productivity, and security in order to create an added value service to the stakeholders of this project which include the passengers, eventual customers as well as the management of Perak Transit.

Moreover, this project supports the realization of 'Perak Maju 2015' by enhancing the values provided by its public transportation sector, which should be considered as a part of the development strategy. This application is targeted for all passengers of Perak Transit buses from every walk of life.

CHAPTER 1 Introduction

1.1 Background Study

Public transportation is government-linked services intended to transport a substantial gathering of individuals in a reasonable, helpful and proficient manner in a specific location (Hamilton, Hokkanen & Wood, 2008; Siembeda, Flores & Havens, n.d.). The service of public transport is widely used in many countries regardless the state of the nation's development, however it is evident that countries of higher income offer better facilities, pay attention to user's safety and operate in a cleaner environment. World Bank (2014) reports that transport sector is a vital agent for economic growth, reduction of poverty, and the accomplishment of the Millennium Development Goals (MDG). The criticalness of public transportation in provincial ranges has been exhibited by the key part it has played in the usage of welfare change in the recent years (Stommes, Brown & Houston, 2002).

Hamilton, Hokkanen and Wood (2008) further explain that public transportation, in general serves to cater three (3) different key areas that include economy, environment and social equity. Public transportation serves each of the 3 components as suggested by Hamilton, Hokkanen and Wood:

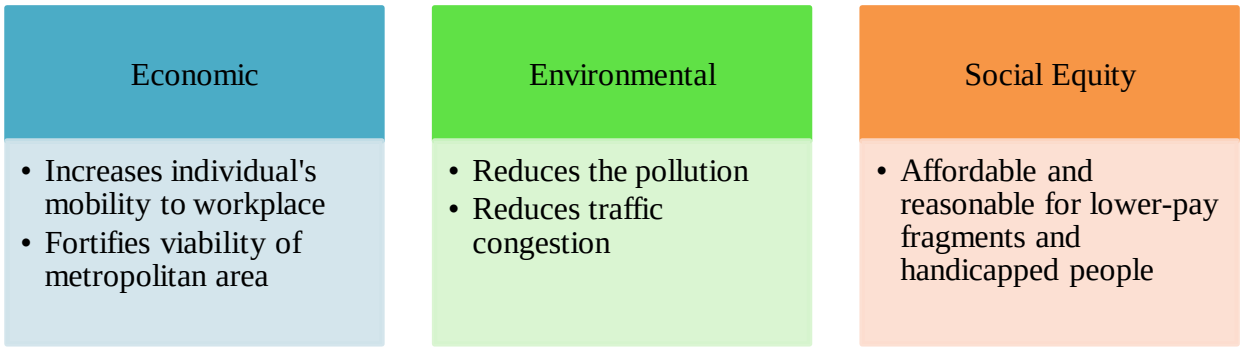


Figure 1: *How public transportation benefits economy, environment and society*

The scope of this final year project will use public buses as the focal point. Bertou and Shahid (2013) describe that there are two (2) major types of public transportation users which are commuters and journeyers. Commuters are individuals who travel frequently over the same route(s) while journeyers, on the other hand, are individuals who travel on peculiar routes in order to reach to the desired destination. Bertou and Shahid further describe that each of the users requires different form of information than the others in which commuters require updated information on details such as delays, alternative routes and the estimation of time of arrival (ETA) whereas journeyers interest more in comprehensive route planning information. Ismail et al. (2012) reports that the Malaysians level of satisfaction is lower than the level of preference. This demonstrates that the nature of Malaysian public transportation system is under the users' desire of the services and facility. Continuation of examination on the user's satisfaction level when using Malaysian public transportation propose the main four characteristics that have strongest association are frequency, travel experience, security and travel time (Ismail et al).

As such this project will develop an Android mobile application (apps) for the bus users of PerakTransit which provides user-friendliness features, updated and comprehensive contents for the users. In this project user-friendliness is defined by the simplicity of the features embedded in the application to enhance the using experience as the application will be used by diversified individuals. Context is defined to be updated and comprehensive in which the information provided is up-to-date and enables users to make quick decision on their travelling journey. The mobile apps will provide real-time location of the PerakTransit buses, ETA to a particular stop as well as the fares.

The rest of this chapter will be organized as follows: the next section will put forward the problem statement of this project. This will be followed with the objectives section, and finally scope of study section.

1.2 Problem Statement

1.2.1 Problem Identification

Among the common problem faced by the users of Malaysian public transportation especially buses is the amount of unproductive waiting time at

a stop. Although the problem is widespread throughout Peninsula Malaysia and East Malaysia, the project focuses on the local public bus service provider, PerakTransit whose service expands in most parts of Perak.

Although the facilities are highly maintained for the comfort of the users, the bus schedule is uncertain in which there are few cases reported that some users experienced a staggering one-hour or more waiting time at a bus stop before the bus arrives. This problem has greatly and negatively impacted the users due to the idle waiting time and distortion in their travelling plan hence; it will increase the level of prejudice of the users towards the service providers as it gives out the impression of being inefficient. One of the main drivers of this project is because of the lack of information pertaining PerakTransit bus services in terms of departure time, bus location and its fares in which these information are deemed essential for an individual take into consideration in order to plan their journey ahead to get a certain destination as desired. The only information made available by the service provider through their website is the routes of the buses.

Figure 2: *Users are enabled to select and identify the routes of the buses*
Source: http://www.peraktransit.com.my/about.html#routes (Obtained on February 4th, 2015)

In order to elicit the current situation and obtain detailed insight of the quandary, few problems have been categorized and depicted, proving the need for the project. The problems are:

Problem 1 ("Need for comprehensive information"): Users do not know the information regarding the buses in which no details are included in PerakTransit's website apart from the routes. Users require information such as arrival time at a stop, total travelling time from one location to another, buses number and the bus fares.

Problem 2 ("Need for productivity"): Users of PerakTransit buses prefer the amount of waiting time at the stops to be reduced. Based on a real case scenario, two (2) foreign exchange students from France waited for an hour and a half to get on a bus from Seri Iskandar (bus stop in front of Universiti Teknologi PETRONAS (UTP) main gate) to Ipoh.

Problem 3 ("Need for safety"): In correlation to the issue of productivity, users are concerned with their safety while waiting for the bus although the crime rate in Perak is decreasing. The longer the users wait at a bus stop, the more the exposure is to danger.

Thus, a detailed study investigates the plausible solution through the use of Android mobile apps to surmount and remedy the current situation faced by the users of PerakTransit by:

1. Allowing PerakTransit users to track the real-time location of the buses
2. Allowing PerakTransit users to obtain the ETA of a particular at a particular stop
3. Reducing the amount of unproductive waiting time at a bus stop
4. Allowing PerakTransit users to efficiently plan their journey

1.3 Research objectives

1.3.1 General Objective

The main of objective of this final year project (FYP) is to generate plausible solution that engages in the scopes of social entrepreneurship and public transportation in Perak by providing added-value services to both users and management of PerakTransit through the use of mobile application technology and real-time information. The mobile apps focuses on the issue of mobility, security, efficiency and productivity.

1.3.2 Specific Objectives

The specific objectives of this project are:

1. To design and develop a tracking system algorithm using GPS to track the real-time location of buses and determine the ETA
2. To design and develop a mobile application to track the real-time location of the buses and provide ETA to the users
3. To evaluate the effectiveness of the mobile application prototype developed based on the outcomes obtained from the users

1.4 Scope of Studies

The scopes covered for this FYP are classified into three (3) categories: the current matter of the subject that the author is looking into, the targeted users of the mobile apps and the development platform(s) to build the prototype and real-live working mobile apps.

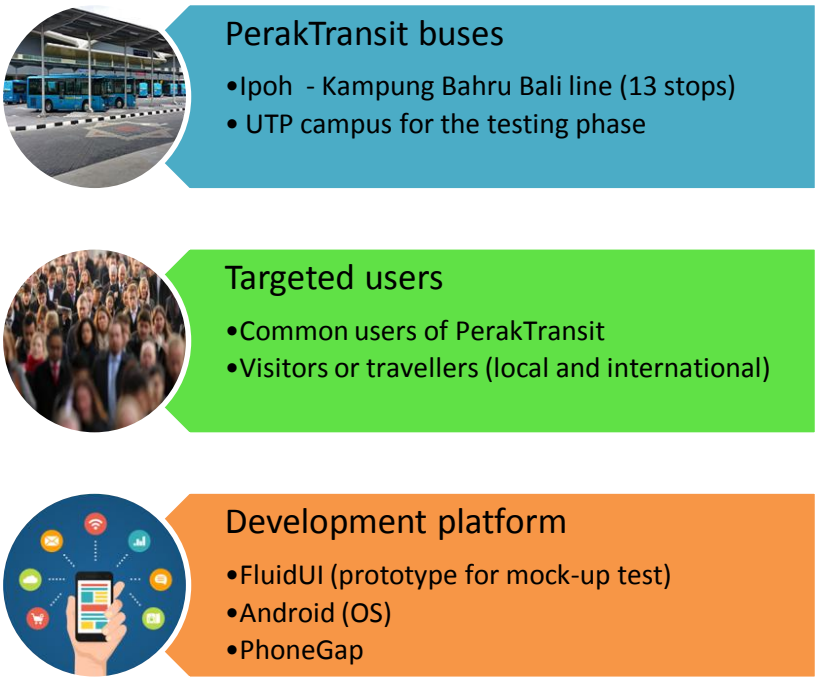


Figure 3: *Scopes of the project in terms of subject, targeted users and development platforms*

CHAPTER 2 Literature Review

This chapter focuses on synthesizing previous researches related to this project in order to support the author's notion of developing the bus-tracking Android mobile application in which it will be divided into four (4) main topics.

By the end of this chapter readers are able to recognize the main quandary that drives the project, technicality aspects of the project which include the technology used as well as the comparison between existing applications of the same nature in order to create competitive edge to the project and finally, the gap analysis and proposed actions pertaining the project.

2.1 The need for the project

The current traffic congestion and the increase rate of pollution in Malaysia in the recent years are the two main outcomes of the rapid growth in the number of privately-owned vehicles (Ismail et al., 2012). Hence Malaysian government has induced the people to use public transportation to remedy the current predicament faced especially to those who reside and work in the urban area (Ismail & Hafezi, 2011). Ismail et al. further explain that although with the initiation of the government policy, majority of Malaysian citizens prefer to use their own vehicles to commute due to the poor quality and bad services from the public transportation provider. The high concentration of the use of privately-owned vehicles affects negatively on the road networks as well as the quality of the environment due to pollution (Aiken et al., 1982). Dahalan et al. (2014) in their study shows that the level of prejudiced among the younger generations in Klang Valley is at moderate level thus this leads the notion that people especially youngsters do not use public transportation as their premier mode of commuting. The usage of public transportation according to a survey conducted with the public transport passengers in the Edinburgh, (Scotland) United Kingdom is often viewed as unsafe, longer travelling time, discomfort and low self-image (Stradling et al., 2007). Gatersleben and Uzzel (2007) also explain that the

dissatisfaction arose among the public transport passengers is due to the delays, stress from its unpredictability and longer travel times.

Oliver (1980) and Anable (2005) both suggest that in order for public transportation to be a part of a sustainable solution in the issue of transportation in the future and to attract more passengers, service providers need to increase their quality of service. Fulfilling and satisfying the passenger's needs are the two main success factors in both business and marketing worlds in which the service providers need to elicit and comprehend the drivers behind the passengers' satisfactions and dissatisfactions towards the current services. The features of cost-friendly and less stressful public transportation provide a significant impact on the passengers as no need of driving and having an opportunity to relax and unwind while using the public transportation is deemed as less stressful (Beirão and Sarsfield Cabral, 2007). Ambak, Atiq and Ismail (2009) and Kamaruddin, Osman and Che Pei (2012) show that safety concern is among one of the various issues that people take into consideration when about to use public transportation as their premier travel mode of choice.

To summarize, learning from past exploration and previous researches demonstrate that public transportation in Malaysia is still an option as a travel mode of choice for some individuals. To pull in prospect travellers, public transport service providers must enhance their administrations to suit and satisfy extensive variety of clients need and desire on the services received. Therefore, as part of the requirement of this project to satisfy the stakeholders which include Perak Transit operators and its passengers – the focus will be based on delivering a mobile application that caters the issues of safety, comprehensive information of the journey, hassle-free environment when using Perak Transit buses and delivering added-value service to increase one's sense of self.

The operating system (OS) for the mobile application will be built on Android as according to Euromonitor (2014) as cited on On Device Research, 65 percent of the smartphone OS used by the people in Malaysia is Android-based phones, as shown in Figure 4 below. This shows that Android applications in Malaysia receive bigger market segment creating a wider opportunity for future commercialization.

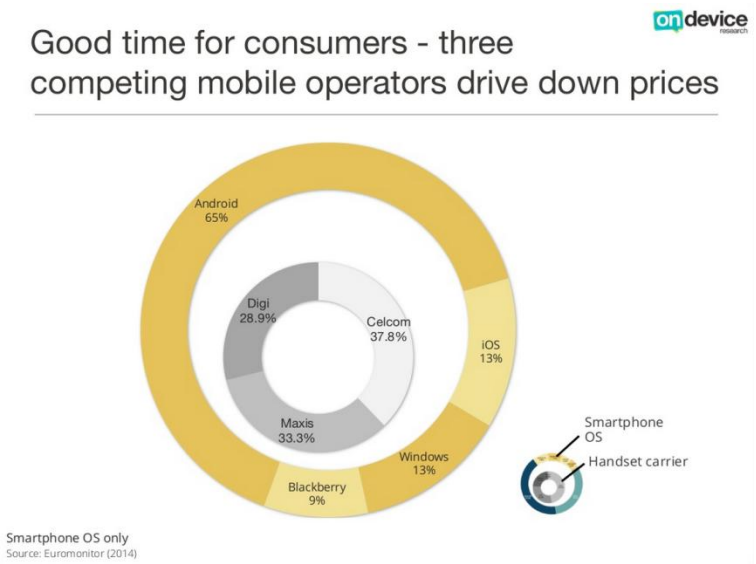


Figure 4: *Breakdown of smartphone OS in Malaysia as in 2014*

2.2 Technologies used to track the real-time location of Perak Transit buses

Prior to the implementation of the project, the author has made a selective decision regarding which tracking technology or hardware to be used based on a number of characteristics that match with the nature of this project. The information is gathered through previous research related to the characteristics of the technology as well as additional reference from reliable websites and expert's blogs. The three (3) tracking technologies are Global Positioning Systems (GPS), Radio Frequency Identification (RFID) and Real-time Location Systems (RTLS).

1. RFID according to ASCOM post (2013) is a widely-used device in the sector of warehousing and logistics purposes. It is explained that RFID is

suitable for the usage in smaller spaces as the tag embedded in certain products are only locatable next to the reader gates. RFID offers more advantages than typical and manually-performed barcode scanner in which it can read up to hundreds of items simultaneously and able to read the tags even in covers, cases or containers (Wikipedia, n.d.). It is often used in tracking of goods as well as machine-readable travel documents at the airports. The cost the tracking device ranges between $US 0.10 and $US 300 (approximately around RM 0.40 and RM 980)

2. GPS is a satellite-based tracking system that provides time and location information and it provides capabilities for the use in common, military and commercialization. ASCOM website (2013) describes that it is best use in the outdoor and global tracking that suggests the tracking system is suitable in use for spacious space. The accuracy of the technology hovers around 10 meters from the exact location. Due to its efficiency and usage policy, the technology is implemented in smart phones for its consumer applications and car navigation systems. The cost of the technology ranges.

3. RTLS is utilized to naturally recognize and track the area of items or individuals automatically, more often than not inside a building or other contained range. Wireless RTLS tags are appended to items or worn by individuals, and in many RTLS, settled reference focuses get remote signs from tags for location determination by the device. It is also often used along with wi-fi connection. It is usually used for assets management and healthcare sectors. RTLS is costly and the accuracy of this device ranges from 1 to 3 meters.

Comparative Study – Hardware/ Technology

Technology Characteristics	Radio-frequency Identification (RFID)	Global Positioning System (GPS)	Real-time Location System (RTLS)
Suitability of implementation	For smaller spaces	For outdoor, global tracking	For assets and people tracking over Wi-fi
Tracking accuracy	Only locatable next to RFID reader gates	10+ meter	Typically ranges from 1 to 3 meter
Cost	Ranges from low-cost to high-cost	Ranges from low-cost to high-cost	Fairly expensive
Usage	Warehousing, logistics	Smartphone consumer apps, car navigator	Assets management, healthcare

Reference: http://integratedwireless.blogspot.com/2013/04/the-difference-between-gps-rfid-and-rtls.html

***Table 1** shows the summary of the characteristics of the three chosen devices to be used in project to track the location of the bus.*

Based on the comparison made and several criteria taken into consideration, the author has decided to implement GPS as the tracking system for this project.

2.3 How is it different from existing products?

Based on the findings of the author's research, there are few similar product offerings from different parties both in local and international scenes. Three (3) existing commercial products have been chosen in which two (2) are Malaysian products and one (1) is from United States of American (USA). The chosen applications and systems are Asian Pacific University ("APU") Bus Tracking and Timetable, Chicago Transit Authority ("CTA") Tracker and myUniBus.

This section explains each of the main feature and/or functionality embedded in the current or product and compared against this final year project. This comparative study aims to build added-value and create a competitive advantage in terms of the services provided to the passengers of Perak Transit, whom is the target audience and key stakeholder to this project.

1. **The platform the application is built on**

   (a) APU is a web-based application. The URL is http://webspace.apiit.edu.my/links/tracking. Figure 5 below shows application interface of APU.

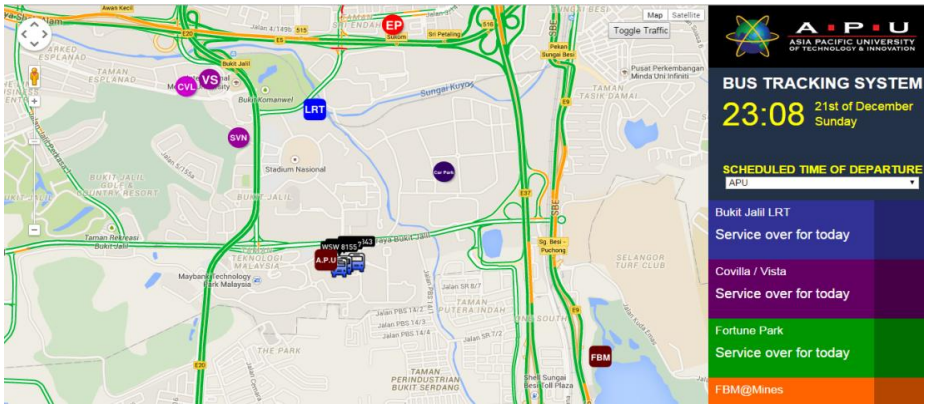


Figure 5: *APU Bus Tracking and Timetable website*

   (b) CTA is a both web-based application and it utilizes push-notification technique through text messaging (SMS) for information release. Figure 6 below shows application interface of CTA.

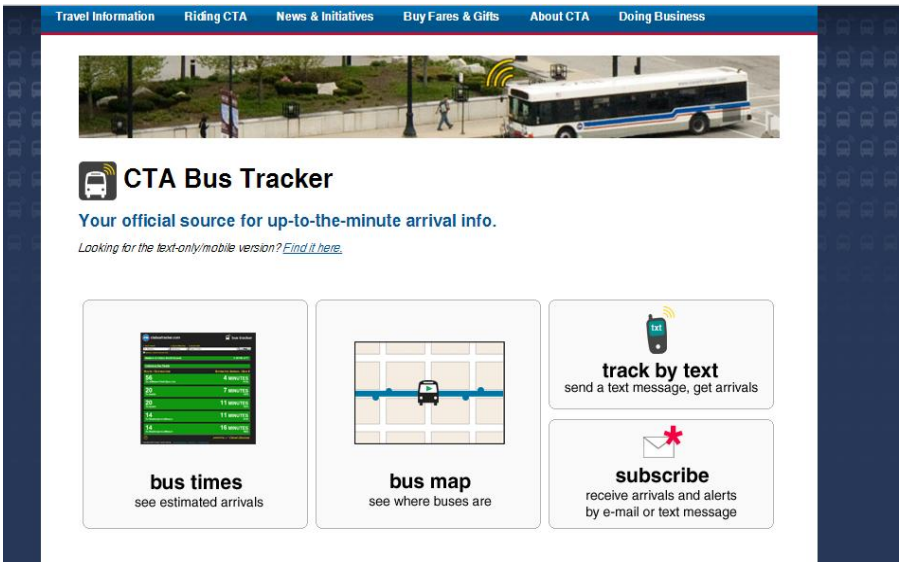


Figure 6: *CTA Bus Tracker*

(c) myUniBus is a web-based application, originated as a social entrepreneurship project of five (5) university students. However, the website is currently suspended due to maintenance. The URL is http://www.myunibus.com. Figure 5 below shows application interface of myUniBus.

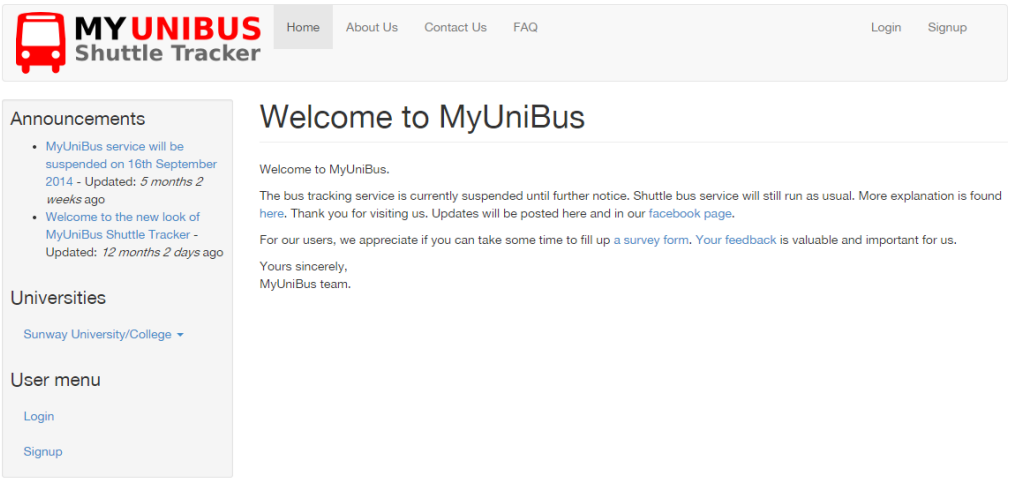


Figure 7: *myUniBus website*

(d) myPerakTransit will be built on Android platform.

2. Scheduled time of departure

Scheduled time of departure of the buses is a function that allows the passengers to attain the scheduled time of the bus leaving from a particular station or stop. This feature however is deemed to be inaccurate depending on the bus drivers. This feature is only applicable to APU.

3. Estimation of time of arrival (ETA)

ETA is a feature that enables users to obtain the time of arrival of a bus at a particular stop. Depending on the technique and technology used, the accuracy of the measurement of ETA varies. This feature is applicable to CTA, myUniBus and myPerakTransit.

4. Fleet routes

Fleet routes enable the users to acquire the routes of the buses, outlining every stop that the particular bus will go to. This allows the users to make

decision regarding which fleet to take as a mode of travel. This feature is only applicable to myUniBus and myPerakTransit.

5. **Fleet locations**

   Fleet locations show the current location of the fleets (buses). This feature is applicable to CTA, APU, myUniBus and myPerakTransit.

6. **Fares**

   Details of the bus fares are made available for the users to plan their journey in terms of cost. This feature is only applicable to myPerakTransit.

Mobile apps / Characteristics/Features	Asian Pacific University (APU) Bus Tracking & Timetable	myUnibus	Chicago Transit Authority Bus (CTA) Tracker	myPerakTransit
Platform	Web application	Web application	Web application, text messages (SMS)	Smartphones (Android devices)
Scheduled time of departure	✓			
Estimation of time of arrival (ETA)		✓	✓	✓
Fleet routes		✓		✓
Fleet locations	✓	✓	✓	✓
Fares	N/A	N/A		✓

***Table 2 shows the** summary of the characteristics and features of the existing bus locator applications, including myPerakTransit.*

2.4 Gap analysis and way forward

Ismail and Hafezi (2011) have reported that due to the rapid increase in the number of privately-owned vehicles in Malaysia, Malaysian government has encouraged the people to use public transportation as an exchange, to remedy the current effect. The charts below show the rapid escalation of the registered privately-owned vehicles in Malaysia.

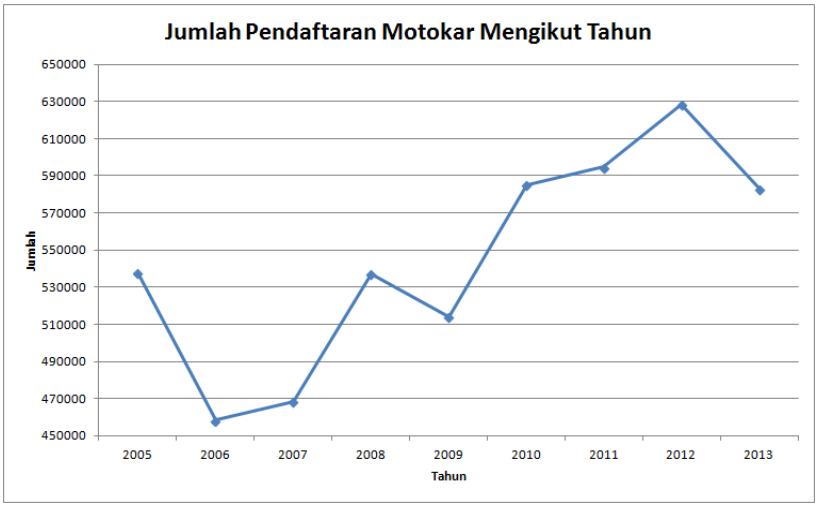


Chart 1: The number of registration of vehicles in Malaysia over the past 8 years. (*Source: Jabatan Pengangkutan Jalan Malaysia - JPJ*)

Studies by Ismail et al. (2012) and Dahalan et al. (2014) exemplify that although with the introduction of the government policy, people are still relying on their own transportations to commute and travel as compared to the existing public transportations because of the quality of service, conditions of the infrastructure as well as the perception of inconvenience that stigmatized the public transportation sector.

The increasing number in private cars in Malaysia has caused many problems which include heavy traffic congestion especially in the urban area, severe pollution problem, insufficient parking spaces and even accidents (Kamba, Rahmat & Ismail, 2007). Hence, some actions need to be taken in order to alleviate the current condition of the public transportation sector in Malaysia and gain the confidence of the people in using and relying on public transports.

However, in the context of this project, the delivery of the outcome will focus on enhancing the power of Perak Transit current passengers and prospective users to attain quicker information regarding the bus information which includes the whereabouts, estimation of arrival time to a particular bus stop, schedule of bus fares and display of driver's working information. The areas covered are based on numerous findings from previous research as explained in the previous sections in this chapter. This project focuses on providing mobility, security, efficiency and productivity to the users.

Through the use of mobile application, this project aims to help reduce the problems faced by the passengers or users of Perak Transit buses by allowing them to have ample travelling details, safer journey and a better experience when using the public transports provided by Perak Transit.

CHAPTER 3 Methodology

This chapter highlights the research methodology which outlines the processes partake in carrying out the research and development of this project – in the context of information technology (IT) project management.

By the end of this chapter readers are able to understand thoroughly on the project development life cycle for *myPerakTransit*, system development methodology used to develop the prototype as well as the end-product, data collection methods to elicit and consolidate vital information for the project, testing involved, timeline of the project which includes key progresses of the project and finally the tools used throughout the project.

3.1 Project Management Life Cycle

In meeting the project requirement – necessary tools and techniques, sufficient amount of skills and knowledge are utilized throughout the activities that are included within the project with the focus of delivering the end-product to the users or clients (PMBOK © Guide, 2012).

Schwalbe (2011) further explains on the concept of project management by incorporating several key elements that ensure the success of the actions taken in completing the project and these elements include scope, cost, quality, time, human resource, communications, procurement, risk and stakeholders managements.

For this final year project, the author has chosen the conventional project management life cycle which separates the project into five (5) phases; initiation, planning, execution, monitoring & controlling and closing in which the processes involved in each of the phases will be later explained in this section.

3.1.1 Project Initiation

Process	Effective date	Output
1. Kick-off meeting with potential project supervisor	12th January 2015	1. Discussion with Dr Noreen Izza from the Knowledge Management (KM) cluster as proposed project supervisor 2. Propose project idea for feedback and improvement prior to proposal submission
2. Project title proposal	23rd January 2015	1. Project title proposal form submission to FYP1 coordinator for approval 2. Approval of project title and assigned to proposed supervisor

Table 3: *Processes involved in project initiation phase of myPerakTransit project*

Refer to ***Appendix 1*** for the sample form of project title proposal submitted to the FYP1 coordinator prior to topic approval and assignment of supervisors.

3.1.2 Project Planning

Processes	Effective date	Output
1. Pilot meeting with project supervisor	29th January 2015	1. Discussion regarding interim report and its components; and product development (prototype and end-product) 2. Set-up weekly meeting for progress checking and consultation session (every Friday every week or fortnight)
2. Gantt chart and key milestones	20th February 2015	1. Draft Gantt chart for both FYP1 and FYP2 2. Final Gantt chart as approved by project supervisor
3. Weekly meeting	Every Friday (every	1. Progress checking on

with project supervisor	week or fortnight – *depending on her availability*) • 29 January – Chapter 1 (Introduction) • 13 February – Chapter 2 (Literature review) • 26 February - Chapter 3 (Methodology) • 6 March – Chapter 4 (Results and Discussion)	interim report components (introduction, literature review, methodology, results and discussion, and conclusion) 2. Review of report writing for each chapter 3. Discussion on next tasks to be performed 4. Submission of logbook to supervisor and FYP1 coordinator

Table 4: *Processes involved in project planning phase of myPerakTransit project*

3.1.3 Project Execution

Process	Effective date	Output
1. Research and development of literature review	27th February 2015	1. Collection of previous related research and documents 2. Consolidation of information for literature review 3. Review of the literature review for improvement from FYP supervisor
2. Development of the prototype using Fluid UI (inclusive survey form distribution for data gathering and analysis)	19th March 2015	1. Initial design for GUI for the mobile application 2. GUI testing on 5 samples (passengers of Perak Transit)
3. Development of mobile application	3rd April 2015	1. Application development of the mobile application using the improved version from the GUI testing and improvement points
4. Testing (System testing)	19th June 2015	1. Feedback on the usability of the mobile application

		2. Identify whether the objectives of the project have been met

Table 5: *Processes involved in the execution phase of the project*

Refer to ***Appendix 2*** for the survey form.

3.1.4 Project Monitoring & Controlling

Process	Effective date	Output
1. Review and maintenance	6th July 2015	1. Updated version of the application 2. Analyze test results for further improvement and/or future improvements 3. Debugging

Table 6: *Processes involved in the monitoring and controlling phase of the project*

3.1.5 Project Closing

Process	Effective date	Output
1. Report submission	29th July 2015	1. Submission of draft dissertation 2. Submission of technical report
2. Project pull-off	24th August 2015	

Table 7: *Processes involved in project closure phase of myPerakTransit project*

3.2 System Development Methodology

Purcell (2015) states that there are numbers of system development life cycle (SDLC) models being formed and introduced by various entities and organizations which include universities and software development experts. Known models as explained by Purcell include the common stages of planning and initiation, design analysis, specification and requirement gathering as well as programming and testing. However, due to the rapid

advancement of technology, newer models emerge to cater to the needs of the new ones. The figure below outlines the archetypal flows used in most SDLC models.

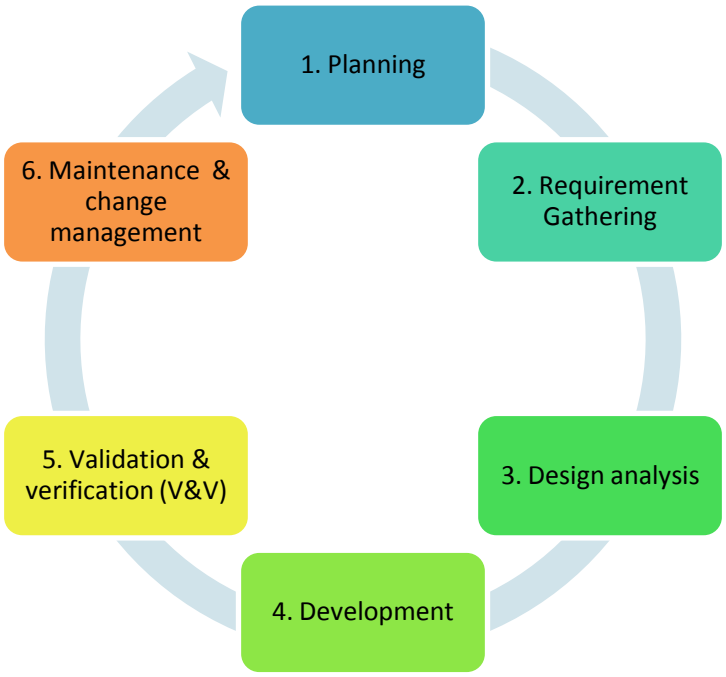


Figure 8: *The common approach used in various SDLC models*

In this section, the author will justify on which SDLC model used for the developing the bus-tracking mobile application. A comparison of three (3) different models will be made and the models selected are waterfall model, spiral model and rapid application development (RAD). The main objective of the comparative study is to identify the potentials for each of the models and opt for the best option to be used in favour of this final year project due to time constraint and nature of the course.

1. **Waterfall model**

   In a nutshell, waterfall model is a step-by-step, traditional approach of software development that gives little or no amount of space for back-dating procedures (moving back from the current phase to the previous phase), which is fitting for projects in which the requirements and scopes are well-defined and properly documented.

2. **Spiral model**

   In summary, spiral model is built based on the weakness of the waterfall and other traditional models. It is an incremental approach and best use in the projects with little set of requirements and functionalities are added in stages. Common risks associated with this approach include scope creep.

3. **RAD model**

   Often known as *rapid prototyping* model, this approach uses prototyping to attain feedbacks from the end-users for future improvements. In a short amount of time, RAD works well however, fast pace of works might result in proper testing cannot be done.

Comparative Study – System Development Life Cycle

SDLCs / Characteristics	Waterfall model	Spiral model	Rapid Application Development (RAD) model
Nature	Sequential	Iterative	Prototyping
Timing	Movement from one phase to another takes time	Incremental in which more works can be done even with little requirements	Takes shorter time through the use of prototype and instant feedback
Suitability	Well-defined projects	Vague or small set of requirements	"Time of the essence" and low-cost projects
Risk factors	Does not allow for alteration once new phase has begun	Scope creep	Proper testing may not be performed

***Table 8 shows the** summary of the characteristics of the chosen SDLC models for the project (Purcell, 2015).*

As a result, based on the comparison made the author has chosen RAD model for the development methodology for developing *myPerakTransit* because of the time constraint of both FYP1 and FYP2 courses as well as the author's other commitments. Refer to **Section 3.1.3** on the implementation of RAD onto this project.

The development of the proposed mobile application will commence on the first week of April 2015, upon the completion of data gathering phase and GUI testing on the initial design of the mobile application. In order to sustain the project quality management aspect, two tests will be performed which is GUI testing and system (functionality) testing to compensate the risk factor that is associated with the RAD model which is to implement the most appropriate testing prior to the product commercialization and project pull-off phase.

3.3 Data Gathering and Consolidation

3.3.1 Survey – Questionnaire

One of the selected methods for the data and requirement elicitation is through the use of questionnaire. The survey process is conducted with five (5) selected samples which can be appropriately considered as the passengers of Perak Transit. The questionnaire is built to be performed in parallel to the GUI testing with the proposed mobile application design.

The questions are designed to gain insight pertaining to the features of the mobile application and to understand the significance of each of the functionalities in the embedded mobile application. There are seven (7) close-ended questions designed for this purpose. The data gathered will be represented later in Chapter 4.

3.3.2 Survey – Interview

Interview involves in-depth oral-verbal communications to gather detailed information through flexibility and human interaction (Kothari, 2004). The interview is done in parallel to the questionnaire to attain a deeper view on the problems faced by the passengers of Perak Transit.

The objectives of conducting interview in the context of the project are as follows:

1. To obtain many and detailed information regarding the proposed GUI of *myPerakTransit*
2. To have a degree of flexibility in gathering further information missed during the walk-through
3. To have a controlled sample environment, in which the interviewee can be selected based on the level of knowledge they posses
4. To incur lower cost

3.4 Testing

System testing is concerned with verifying and validating a whole framework of the system in light of its terms and specifications, and includes a few tasks for example, functional testing (testing from behavioural portrayals of the system or software) and performance testing that aims to examine on issues such as response time (Briand and Labiche, 2002).

The main objectives of the testing phase are:

1. To gain feedback of the prototype design of the mobile application through the use of GUI testing, for recommendation and improvement purposes
2. To verify and validate the effectiveness and efficiency of the developed mobile application through the use of system (functionality) testing in terms of providing the correct output based on its defined functionalities (real-time location of buses, estimation of time of arrival at a specific stop, bus fares, driver's details)

Therefore, two forms of testing will be performed in this project – graphical user interface (GUI) testing and system (functionality) testing.

3.4.1 Graphical User Interface (GUI) testing

GUI testing can be described as non-functional testing performed onto any system or software developed for quality and assurance. GUI is often

described as usability testing and it comprises of three (3) sections: accessibility, navigation and content (*www.softwaretestingclass.com*, 2013).

Using this approach the users are able to give out their responses in an effort for the author to measure the product's ease of use, response time for each transaction or task required by the mobile application to function as well as the user's perception of the commercialization values that the product possesses. Thus, by implementing the strategy outlined by the previous reference, the author will perform the GUI testing based on the 3 sections.

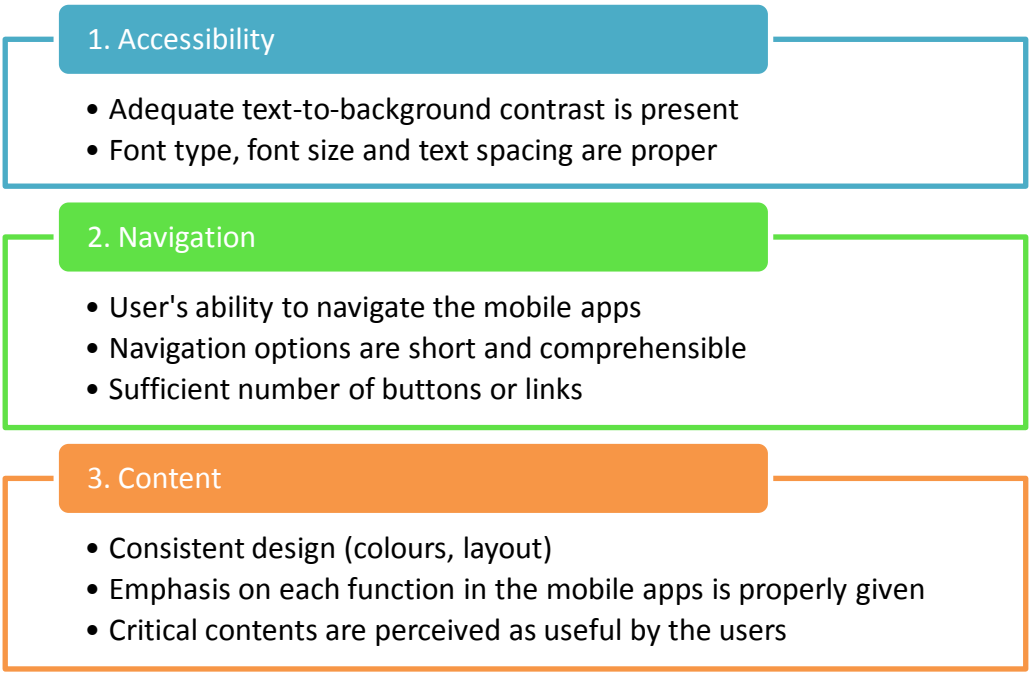


Figure 9: *GUI testing plan for myPerakTransit mobile application. Adapted from www.softwaretesting.com (2013).*

These are the steps taken by the author in performing the GUI testing:

1. The five selected samples are given the prototype of the initial design interface of the proposed mobile application which was built on Fluid UI
2. The users provide feedbacks based on their critical judgment or perception of the application
3. The GUI testing is performed in parallel to the interview and questionnaire distribution.

4. Improvement points are received by the authors from the samples and considered to be implemented in the project based on the scope covered. Additional context will be discussed with the FYP supervisor.

3.4.2 System (functionality) testing

The verification and validation that a software, system or application should perform and function in accord to its pre-defined design specifications are conducted through the implementation of functionality testing, according to ISTQB. It is often conducted prior to the commercialization of the particular end-product to ensure delivery of highest quality to the end-users. ISTQB describes that some of the tasks undertaken in functionality testing include checking the core application functions, processing of input & output, menu functions and installation & setup. The figure below shows the framework of functionality testing that the author will perform.

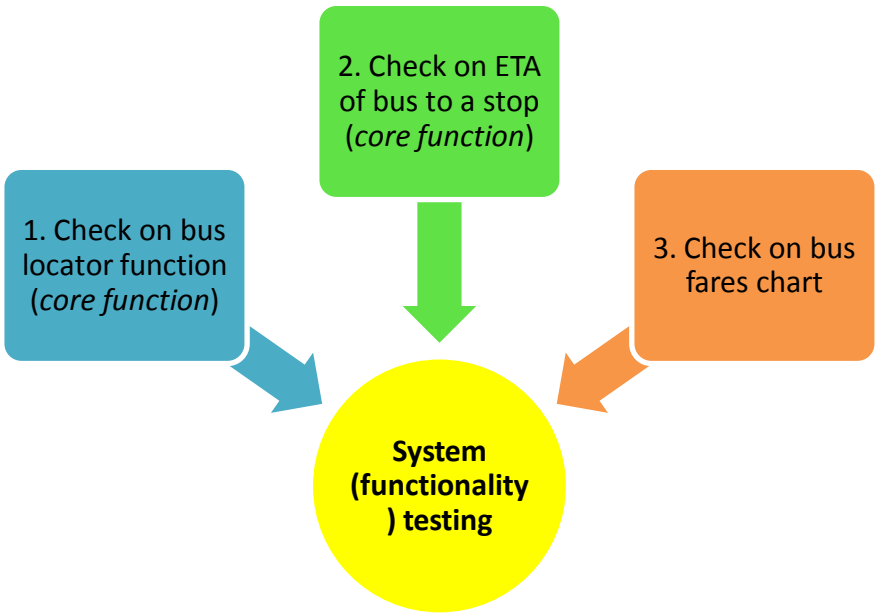
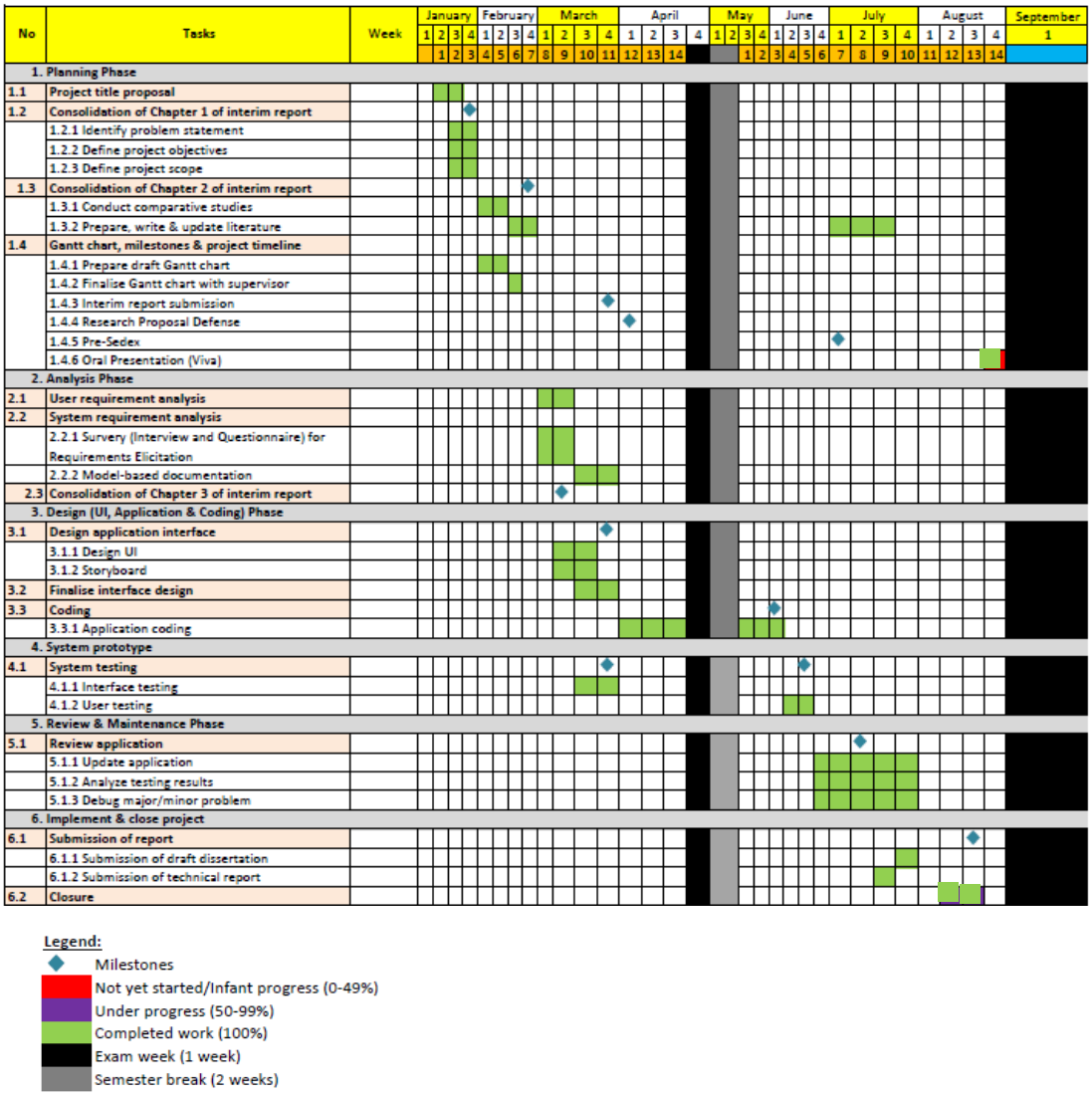


Figure 10: *Framework for performing system (functionality) testing*

These are the approaches considered by the author to perform the system testing focusing on the functionality of the mobile application:

1. Scenario cards are devised based on each of the built functionalities embedded in the mobile application.
2. Each functionality (use case) is represented by one scenario card. In the scenario card, up to 5 (five) questions are designed for the users to answer while using the final version of the product.
3. The results are collected and discussed with the updated Chapter 4 during FYP2 phase.
4. Problems or discretions found will be rectified and updated. Gantt chart and key milestones

3.5 Gantt Chart & Key Milestones



The figure above shows the timeline of this project throughout the two phases: FYP1 and FYP2, including all key important tasks set as milestones. This project is divided into six (6) distinct phases which are planning phase, analysis phase, design phase, system prototyping, review & maintenance phase, and implement phase as well as project closure. The total timeline for the project spans up to 28 weeks.

3.6 Tools to be used

In the process of completing the project, numerous tools have been used. These are the list of tools used throughout the project:

1. Fluid UI (www.fluidui.com)
   Developed and maintain by an Irish development organization, Fluid UI is a wire-framing and prototyping tool used to develop various applications that serve on many platforms which include iOS and Android and allows user to design and create their prototype as desired, in a rapid manner (FluidUI, n.d.).

2. PhoneGap is used for the development of the mobile application using Web technologies such as HTML, CSS and Javascript.

3. Microsoft © Excel is used to create and develop Gantt chart and for project monitoring purposes. The author has chosen this option over Microsoft © Project due to the ease of the use and Excel can serve the controlling actions because of the simple nature of the project (not much complexity).

4. Questionnaire form is be used to elicit the opinions of the samples selected for the data gathering stage. The questionnaire as mentioned is designed to solicit the perspectives and perceptions of the users of Perak Transit towards the proposed mobile application based on its proposed functionalities.

5. Scenario cards are used with the respondents for the user testing which include the evaluation of the functionality and the overall system of the developed mobile application in which the results are discussed in Chapter 4. The focus of the testing is to evaluate the product based on the criteria of ease of navigation, ease of use and accuracy of the information provided.

CHAPTER 4 Results & Discussion

This chapter places a focus on the outcomes obtained from a number of data gathering techniques used in this project which include close-ended questionnaire, requirements from previous research as well as user interface testing for the proposed mobile application.

By the end of the chapter, readers are able to understand and relate the purpose of this project in order to alleviate the current problem faced by the society or community in terms of using the public transportation service provided by Perak Transit as well as the results elicited from numerous data gathering methods used and the proposed design of the GUI for the mobile application.

4.1 Conspectus of related subjects

4.1.1 Previous research findings

Based on the problem identification conducted in Chapter 1 of this project, unproductive waiting time for a certain public transport at a particular stop is recognized among more problems faced by the users of Malaysian public transportation. Ismail, Ismail, et al. (2012) have found and noted in their research, that the level of satisfaction of Malaysian public transportation users is lower than their expected preference. They further elaborate on the causes and listed the following attributes contributing to their findings pertaining to the lower satisfaction level: frequency, travel experience, security and travel time.

Stradling et al. (2007) have conducted a survey and found that people associated public transportation with issues and views such as not safe, lengthy travelling period, excruciating and low self-image. This notion is agreed by Gatersleben and Uzzell (2007) that later further elaborated that the dissatisfaction arose among the public transport passengers is due to the delays, stress from its irregularity and longer travel times which in the end do not provide a good travelling experience among the users of the public transportations.

In the author's opinion, commuting using public transportation services is imperative in the state of Perak that wishes to become a developed region by the year 2015 following the plan of "Perak Maju 2015". However, the development of all-aspects needs to be focused on and this effort should also include its public transportation system that provides value to every people from every walk of life.

4.1.2 Proposed graphical user interface (GUI) for "myPerakTransit" mobile application

The proposed GUI is designed based on the requirements obtained from previous research findings that explore on the factors that drive the dissatisfaction among Malaysian public transportation users. The GUI is designed based on the following model:

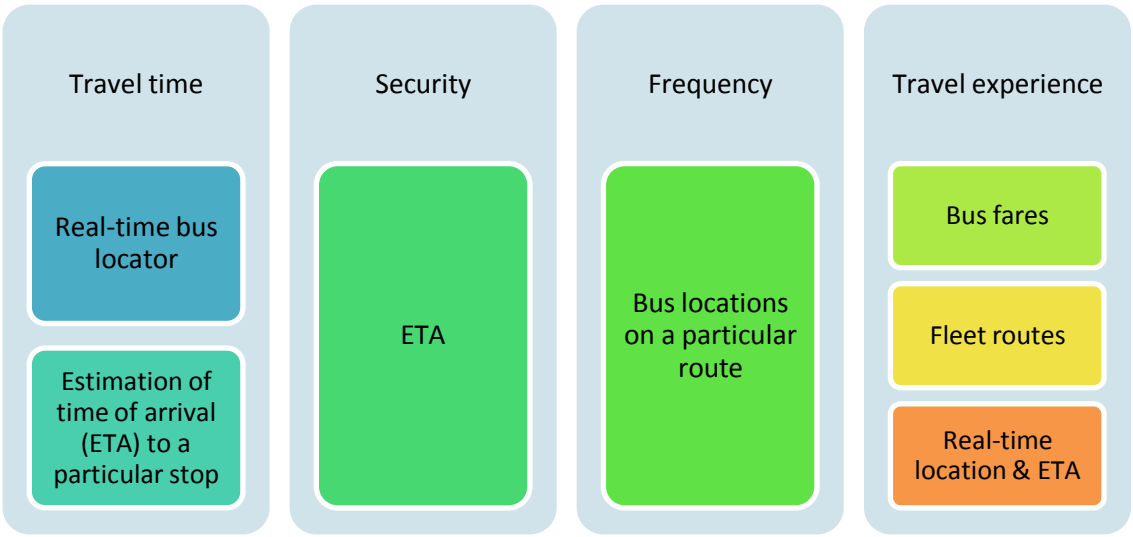


Figure 11: *Model of GUI for the proposed mobile application. Adapted from Ismail et al. (2012)*

The GUI is designed on FluidUI – fast and friendly mobile application prototyping tool. Based on the model created, the design of the GUI of the mobile application is developed. The proposed GUI for "myPerakTransit" is as follow:

1. Real-time bus locator and estimation of time of arrival for each bus at a particular stop

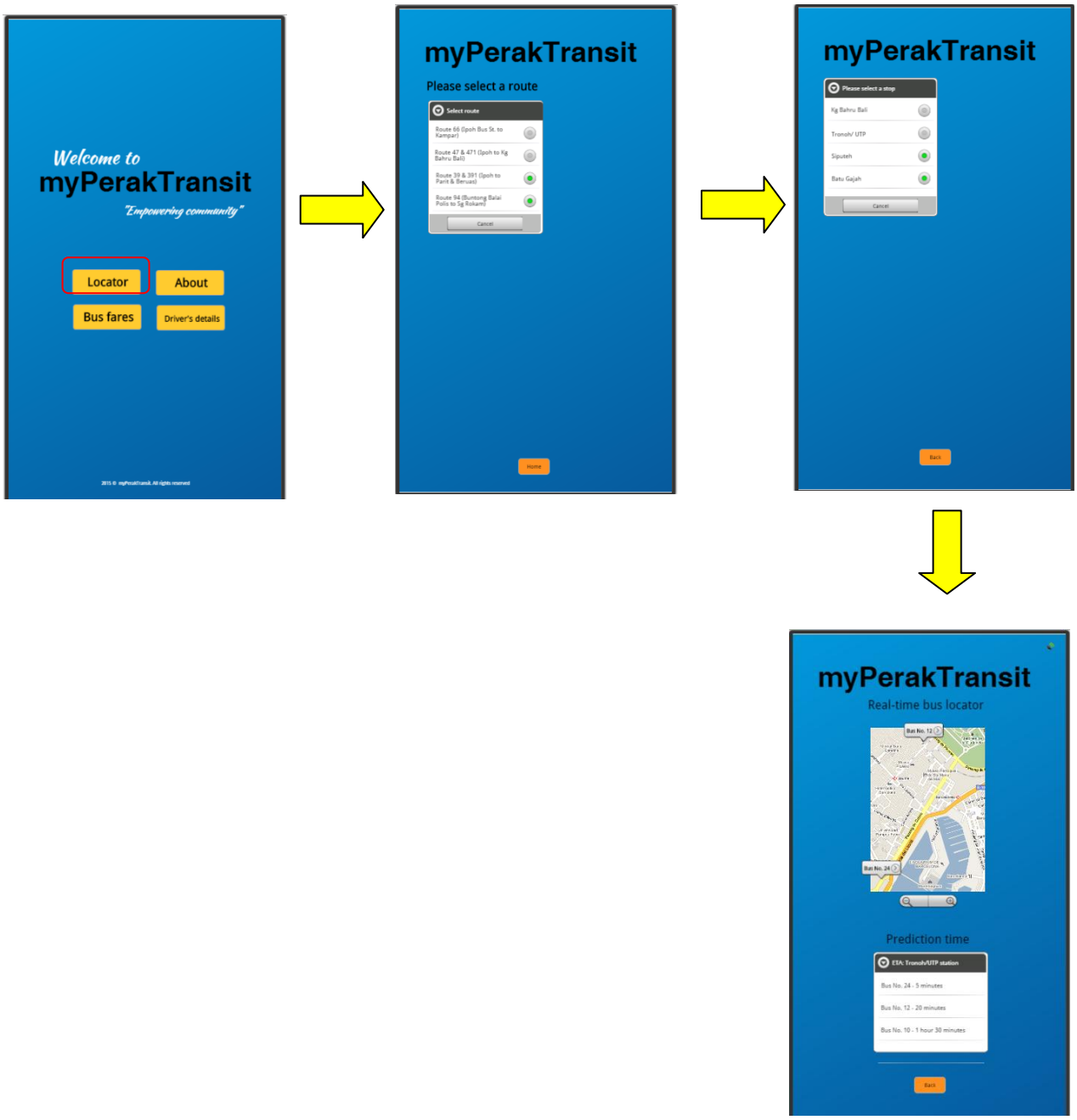


Figure 12: *Proposed GUI design for bus locator and ETA functionalities*

2. Bus fares

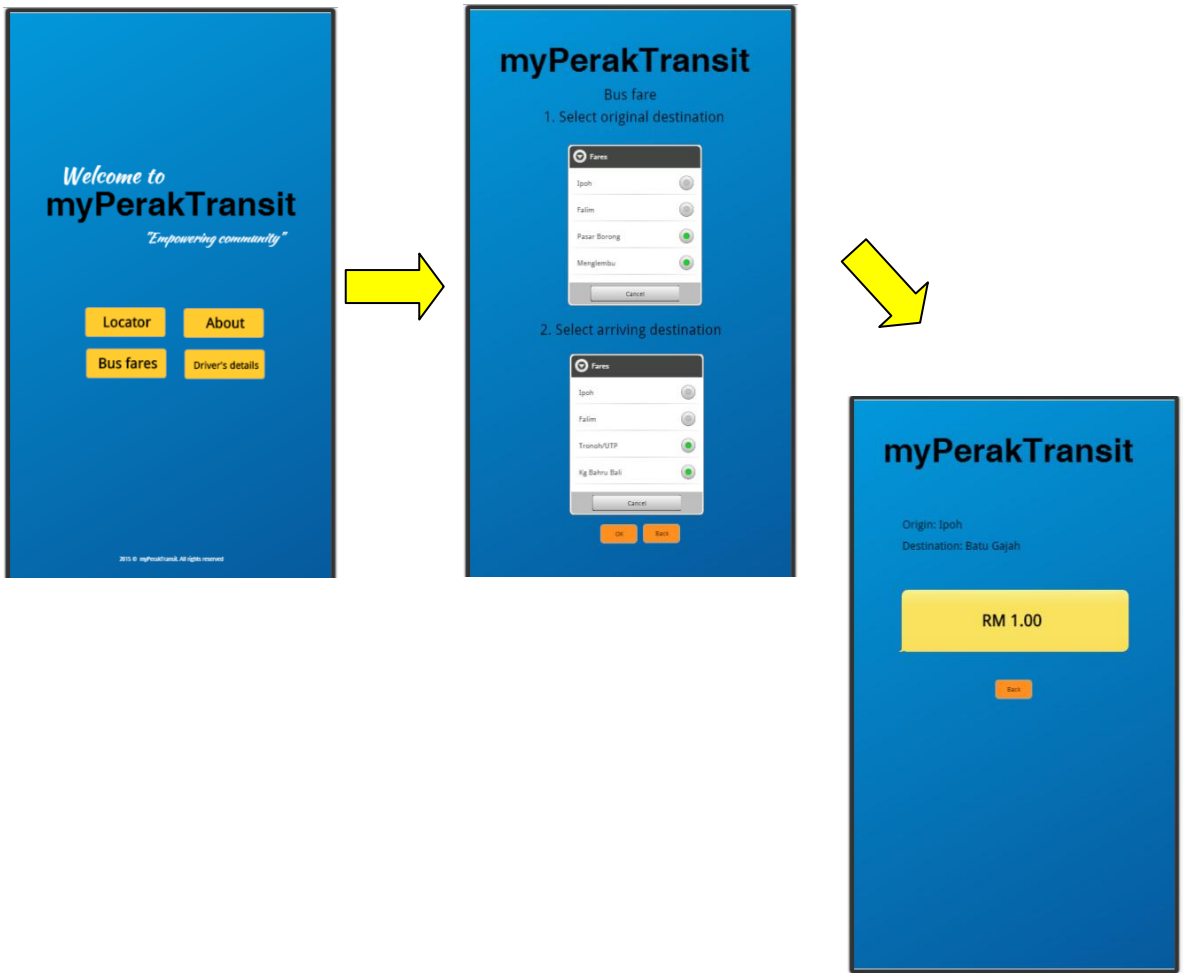


Figure 13: *Proposed GUI design for bus fares*

3. Driver's details

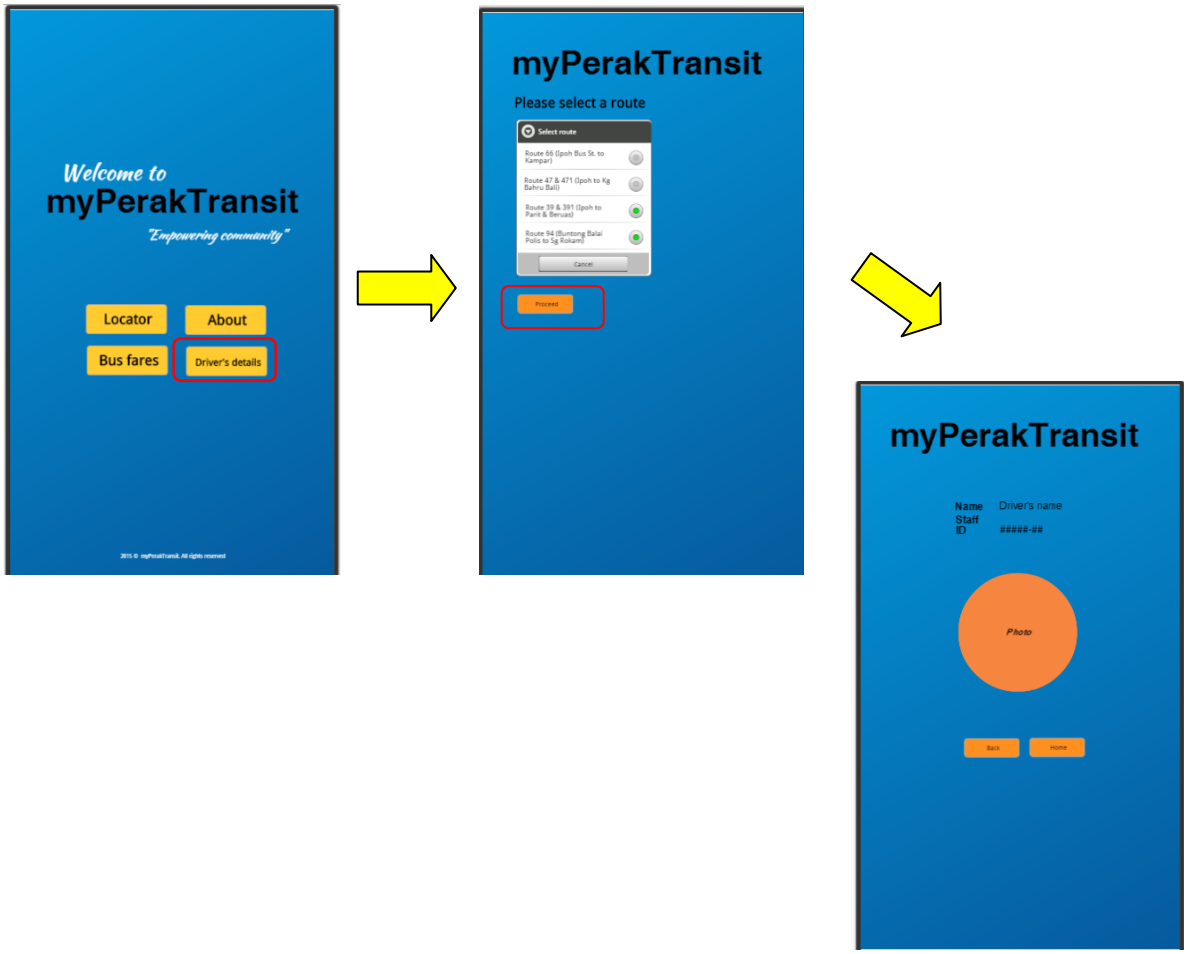
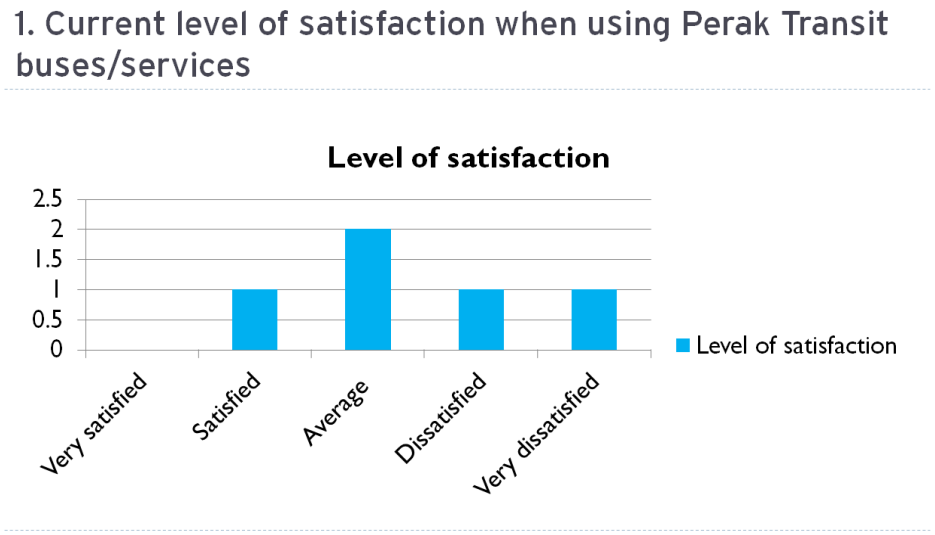


Figure 14: *Proposed GUI design for bus driver's details*

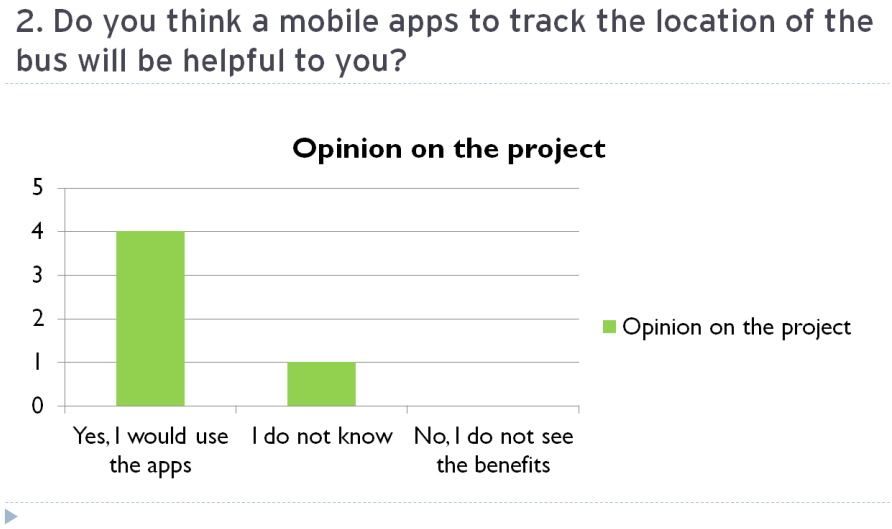
4.2 Data and Finding Analysis

4.2.1 Finding Analysis

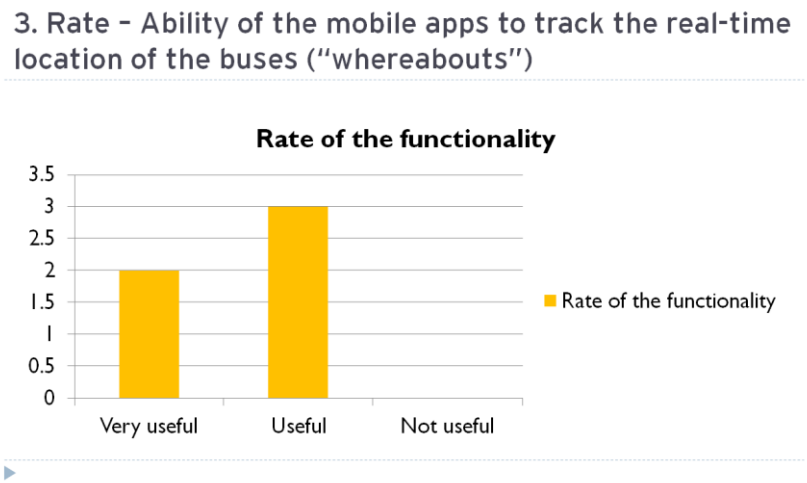
One of the requirements elicitation methods conducted is survey among a selected sample of individuals who rely heavily on Perak Transit buses or persons who have used the services to commute for personal or business purposes. The survey aims to validate the proposed functions of the mobile application in providing efficiency and productivity to their needs whenever they use Perak Transit buses. The following are the interpretation results from the survey conducted.



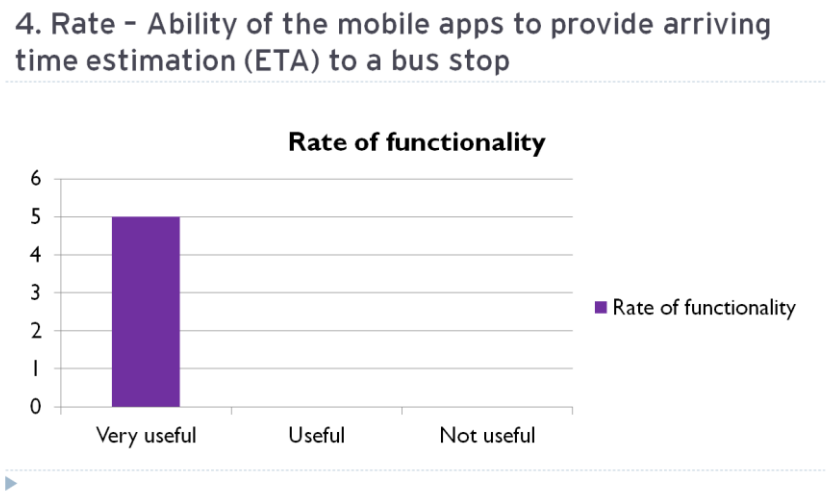
Graph 1: *Current level of satisfaction of Perak Transit users based on 5 selected samples*



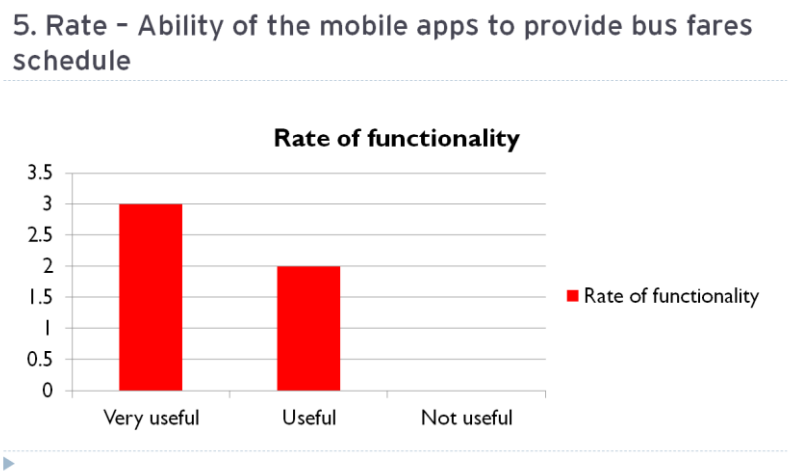
Graph 2: *Opinions of the samples regarding the project of myPerakTransit*



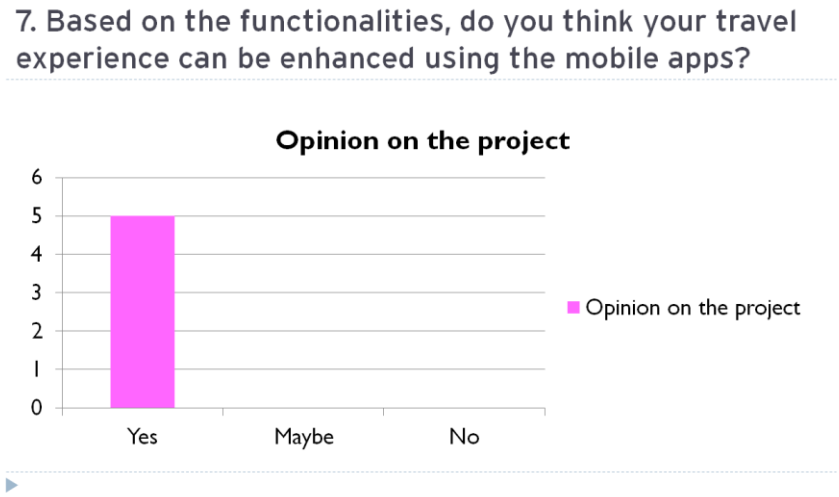
Graph 3: *User's rating on the mobile apps ability to track the real-time location of Perak Transit buses*



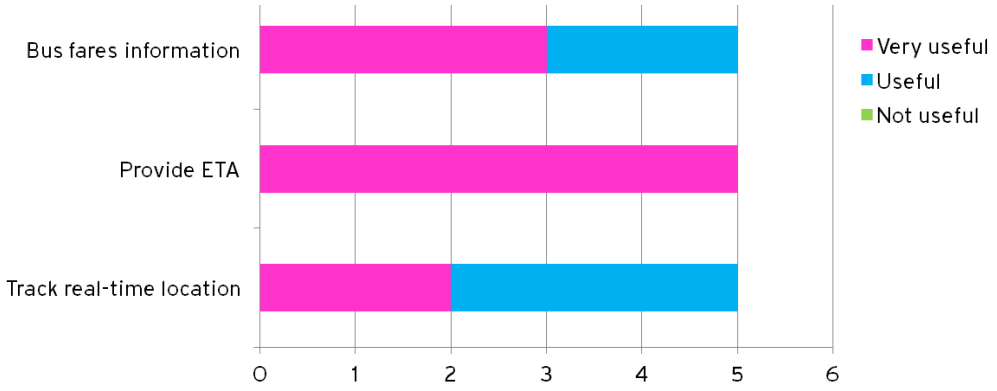
Graph 4: *User's rating on the mobile apps ability to provide ETA*



Graph 5: *User's rating on bus fare schedule functionality*



Graph 6: *Expected feedbacks from users regarding the benefits of the mobile apps*



Graph 7: *The summary of the feedback from the questionnaire conducted with the selected respondents.*

The graph (*refer to Graph 7*) shows the collective results obtained from the discussion with the respondents regarding the proposed mobile application. In general, the proposed mobile application has received positive feedback from the respondents in terms of the proposed functionalities which to provide ETA, real-time location and bus fare. Based on the result, 100 per cent of the respondents (5 of out of 5 samples) agreed that they are looking forward for the ETA functionality of the mobile application thus, the functionality will be given more emphasis in order to make sure that it is working.

In parallel to the survey conducted, an interview session is also conducted with the samples to obtain further understanding and gain insight pertaining to the problems faced by the passengers or users of Perak Transit as well as finding more opportunities to alleviate the current situation through the implementation of this project.

Below are the excerpt relating to the problems faced by users when using Perak Transit buses, based on interviews conducted with the same samples of the survey.

"The lateness of the buses was only around 30 to 40 minutes previously, but currently I waited for more than one hour for a bus…" – Sample 1

"I don't know when the buses will come because (there is) no schedule (being released) by (Perak Transit) operator" – Sample 2& 4

"I just go and wait (for the bus) like I what (exact timing based on user's experience) do (previous days) yesterday" – Sample 3

"…difficult to report (misbehaving of drivers, traffic offence committed) when you don't know (the details of) the driver" – Sample 5

4.2.2 GUI Testing and Enhancement

Using the FluidUI prototype design, the GUI interface testing is also performed with the samples to attain improvement points which later can be used to enhance the GUI design and for the development of the mobile application in the second phase of the project ("FYP2"). The points below are considered for the enhancement of the interface design for *myPerakTransit* mobile application.

1. To include Driver's details and bus fare information in the same function of bus locator. Apart from locating a specific bus and its estimated time of arrival (ETA), users are also allow to know how much is the fare and the bus driver on-duty.
2. To include Fleet routes or the stops can be put onto the map.
3. To include 'Contact Us' page so that users can directly contact or make report pertaining the service. *
4. To include functionality that can report the details of the bus driver easily regarding traffic offenses or misconduct. *

**To be considered*

Upon the consolidation of the feedbacks from the samples, the GUI is enhanced based on the improvement points to ensure usability of the mobile application during system (functionality) testing prior to the application deployment and project closure. Below is the new, enhanced GUI.

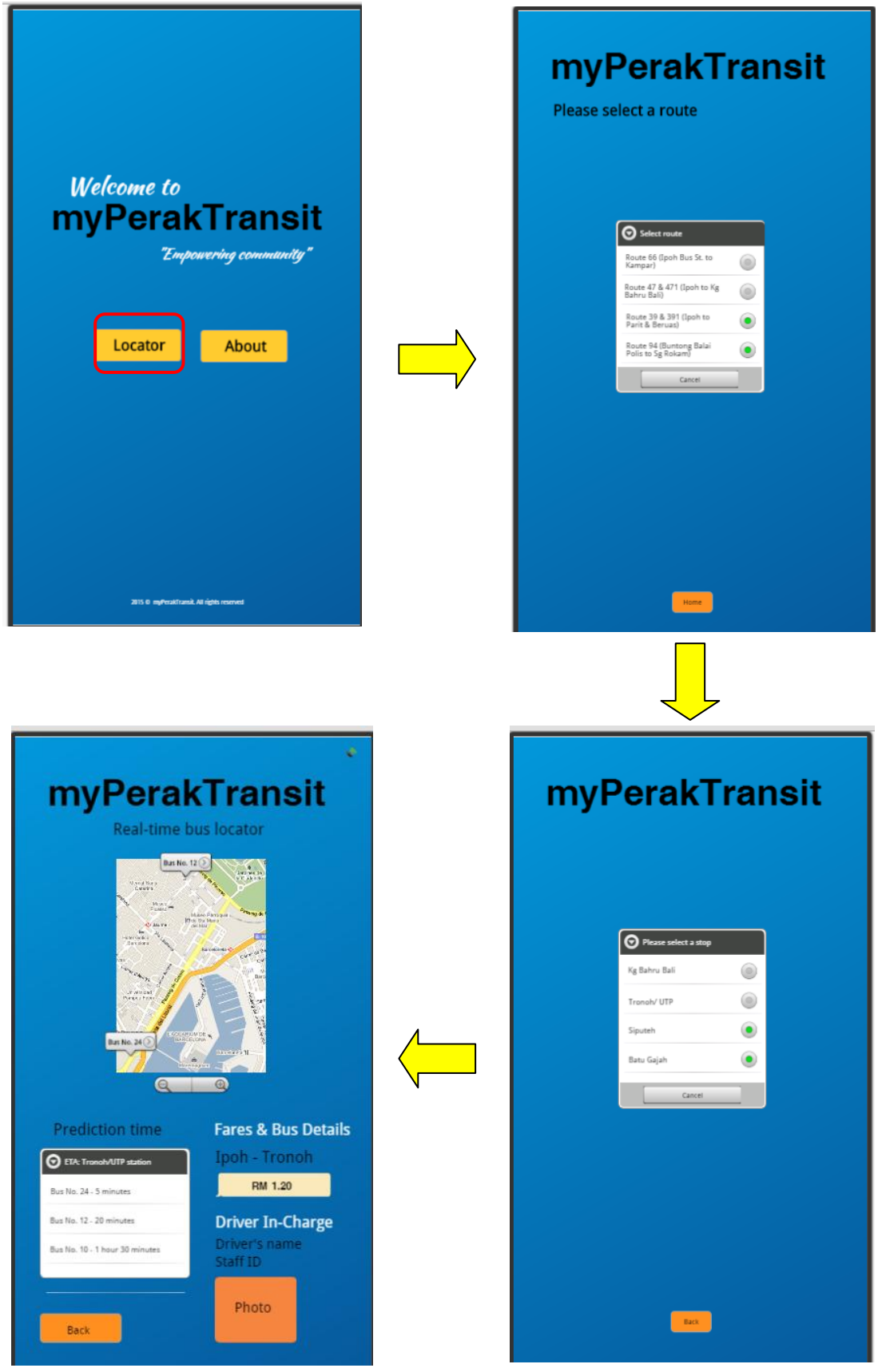


Figure 15: *Updated GUI of myPerakTransit after the GUI testing with the samples*

4.3 Model-based Requirements Documentation

4.3.1 Use Case Diagram ("Use Case")

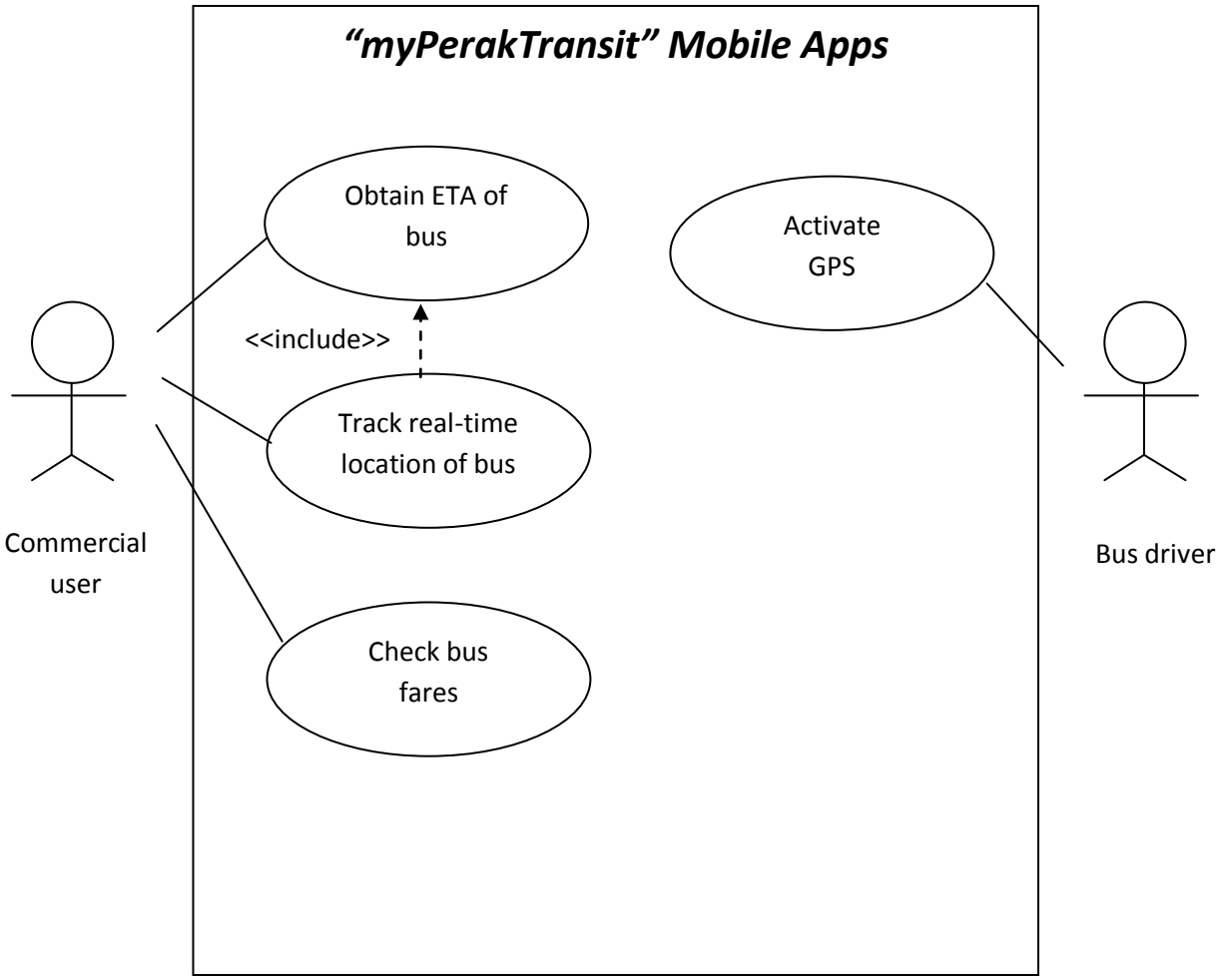


Figure 16: *Use case diagram for myPerakTransit*

4.3.2 Data Flow Diagram (DFD)

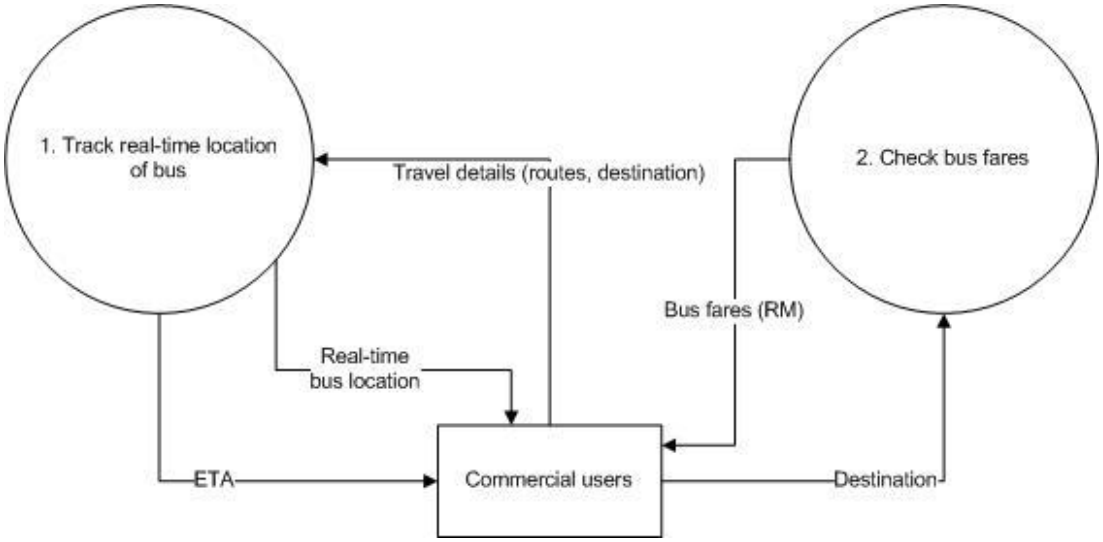


Figure 17: *Data flow diagram for myPerakTransit*

4.4 User Testing

4.4.1 Analysis from Scenario Cards

The user testing was conducted with five (5) selected samples as the potential passengers of Perak Transit buses who consist of university students, lecturers and staffs of Universiti Teknologi PETRONAS. The testing was to evaluate the mobile application in terms of its usability, accuracy and ease of navigation when using the developed mobile application. The testing was performed by:

1. Scenario cards which consist of a series of questions pertaining to the functions of the mobile application were prepared prior to the planned testing date.
2. Users tested the mobile application as they answered the questions. All questions were made compulsory in order to ensure the quality of the feedback and results of the testing.
3. The results from the testing were analysed and transformed into graphical facts using charts.

The components of the testing are designed as follows:

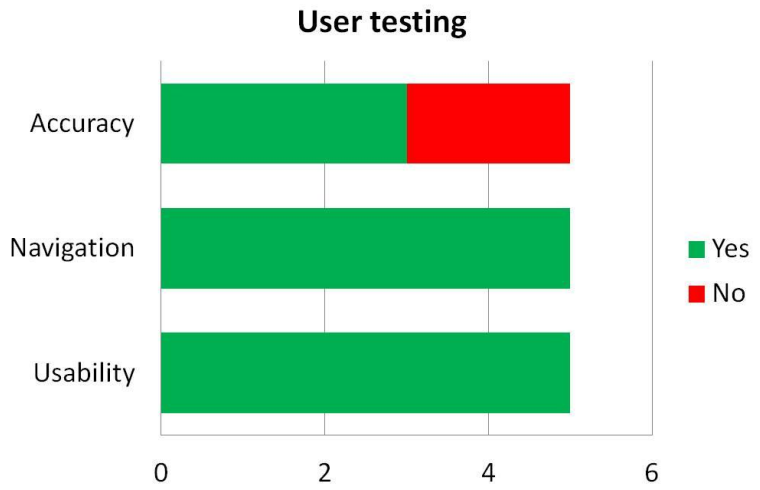
1. Accuracy – How accurate the mobile application in terms of providing the ETA of the bus at a particular bus stop? Is there any deviation from the information provided through the mobile application? How much is the deviation occurred?

2. Navigation of the mobile application – Is it easy for the users to navigate throughout the mobile application developed? How easy for the users to obtain the travelling information (bus ETA, distance, bus location, and bus fare)?

3. Usability – How easy it is for the users to use the mobile application developed? What is the reaction of the users towards the developed

mobile application? What is the potential of the product being commercialized for future use?

The result of the user testing is as follows:



Graph 8: *The results translated from the scenario cards provided by the users during the user testing(refer to Appendix 1) for the sample of the scenario card.*

From the results above, it is evident that 40 per cent of the respondents (2 out of 5 samples) stated that the mobile application has provided incorrect information (ETA of the bus at a stop) with deviations occurring. The deviation, however does not affect the overall function of the developed mobile application as the figure is only miniscule. Although with small deviation, the problem is noted and will be improved in order to ensure full user's satisfaction when using the product.

Next, all users are satisfied with the navigation component designed in the scenario cards. All users stated that they only needed 3 clicks from the home button before obtaining the travelling information that the mobile application promised to provide, leading them to make informed decisions regarding their travel.

Last but not least, the users are also satisfied having all respondents providing positive feedback in the usability component of the designed scenario cards. The users also mentioned that they could see the potential of the mobile application being commercialized to help alleviate the current problem facing the passengers of Perak Transit buses.

4.4.2 Developed Mobile Application: Navigation process

The figure (*refer to Figure 18*) exemplifies the step-by-step approach on the how users will navigate through the mobile application. At **(1)** the users will encounter the home page of the mobile application which has three functions (bus locator, bus routes and *About Us* page).

If the user selected 'Bus Locator' they will have to go through the locator page like in **(2)** in which they have to input their current location of bus stop and desired destination. The next page will then have the output of ETA of the bus, distance from the current station the user is at and bus fare (**3**).

If the user selected 'Routes' they will go to the page where the routes of the bus inclusive the stations the bus will stop at, is displayed in the form of map and photo like in **(4).**

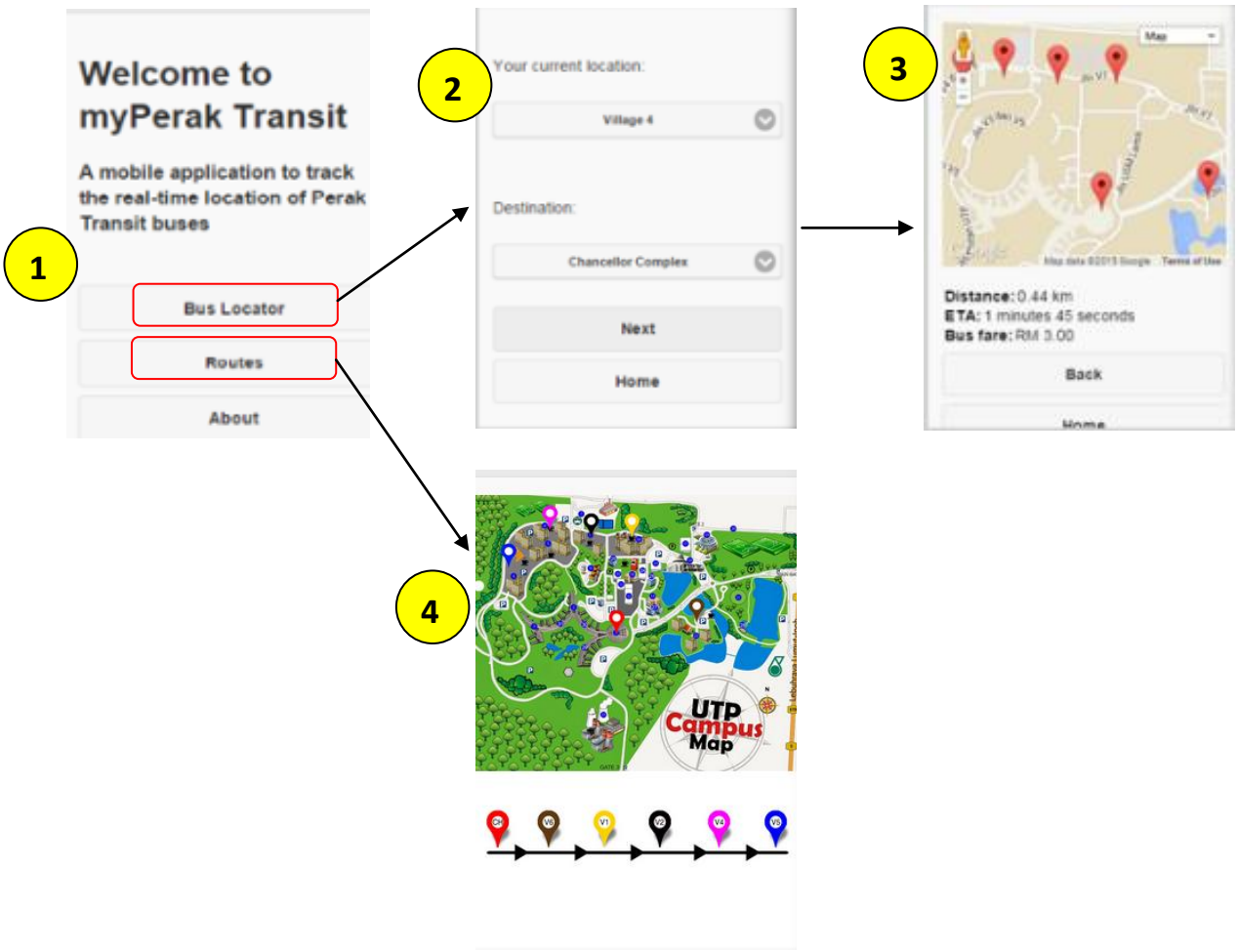


Figure 18: *Navigation of the mobile application*

This section explicates the development stages of the mobile application using a cross-platform mobile application development tool using Web application development languages.

5.1 Phonegap: A cross-platform mobile application development tool

PhoneGap is a mobile development framework which allows mobile applications to be developed without relying too much on platform-specific APIs like those in Windows Phone, iOS or even Android (Wikipedia, n.d.). It allows mobile applications to be built that can run on numerous devices as it is a cross-platform development tool.

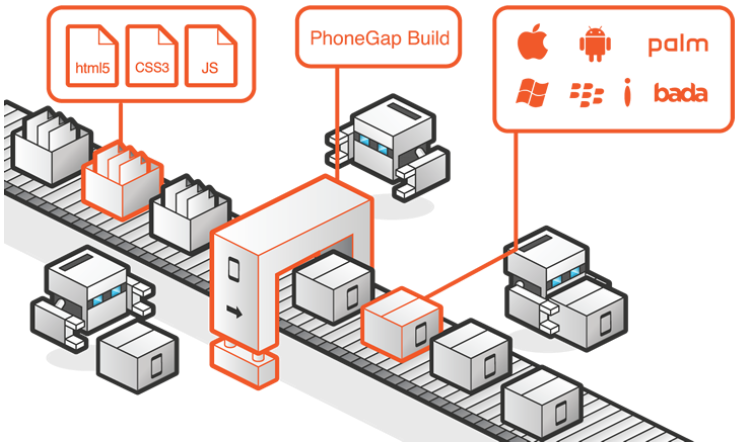


Figure 19: *The graphical representation of how PhoneGap works*

The accomplishment of most of the development work can be achieved through designing and writing the user interface of the product using Web development languages such as Hypertext Markup Language (HTML), Cascading Stylesheet (CSS), and Javascript (refer to *Figure 18*). PhoneGap's development tools bundle the Web coding files into platform-specific deployment packages. Applications built with PhoneGap use the mobile platform's Web view to render content. As such, the content will appear nearly identical on each platform, much as any Web page would (Traeg, 2014).

PhoneGap essentially wraps a Web view of your HTML, CSS and JavaScript in a native application. This is required because the Web view in an application does not inherently support many device features, such as access to the file system or the camera. PhoneGap has a bridging mechanism that allows JavaScript running in the Web view to invoke native code contained in the application (Traeg). PhoneGap comes complete with plugins to support device capabilities such as the following:

- accelerometer,
- camera,
- contacts,
- file system,
- media playback and recording,
- network availability.

5.2 Source Code (HTML, CSS, Javascript) - User's application

The figures below show the snippet of the coding used to develop the mobile application using HTML and Javascript files.

```
<DOCTYPE html>
    <head>
        <title>myPerakTransit</title>

            <link rel="stylesheet" href="./jQuery/jquery.mobile-1.4.5.min.css">
            <script src="./js/jquery.js"></script>
            <script src="./demos/_assets/js/index.js"></script>
            <script src="./jQuery/jquery.mobile-1.4.5.min.js"></script>
            <script src="maps.js"></script>
            <link rel="stylesheet" href="stylesheet.css">

            <!--Accessing Firebase database -->
            <script src='https://cdn.firebase.com/js/client/2.2.1/firebase.js'></script>

            <!-- define style for Google Maps display -->
            <style>
                    #map_wrapper {
                        height: 250px;
                    }

                    #map_canvas {
                        width: 290px;
                        height: 250px;
                    }
            </style>
    </head>

    <body onload="getCoord()">
        <!-- Start of first page @ HOME -->
        <div data-role="page" id="page1">

            <div data-role="header">
                <h1>myPerakTransit</h1>
            </div><!-- /header -->
```

Figure 20: *Snippet of the HTML coding to develop the user's application*

```
jQuery(function($) {
    // Asynchronously Load the map API
    var script = document.createElement('script');
    script.src = "http://maps.googleapis.com/maps/api/js?sensor=false&callback=initialize";
    document.body.appendChild(script);
});

function initialize() {
    var map;
    var bounds = new google.maps.LatLngBounds();
    var mapOptions = {
        mapTypeId: 'roadmap'
    };

    // Display a map on the page
    map = new google.maps.Map(document.getElementById("map_canvas"), mapOptions);
    map.setTilt(45);

    // Multiple Markers
    var markers = [
        ['Chancellor Complex', 4.382275, 100.969661],
        ['Village 1', 4.387859, 100.970326],
        ['Village 2', 4.387822, 100.967751],
        ['Village 4', 4.388148, 100.965401],
        ['Village 5', 4.387779, 100.963572],
        ['Village 6', 4.382800, 100.974355]
    ];

    // Info Window Content
    var infoWindowContent = [
        ['<div class="info_content">' +
        '<h3>Chancellor Complex</h3>' + '</div>'],

        ['<div class="info_content">' +
```

Figure 21: *Snippet of the Javascript file*

5.3 Source Code (HTML) - GPS real-time locator

The figures below show the snippet of the coding used to develop the mobile application using HTML to track the real-time location of the bus using the mobile phone's GPS technology.

```
        watchID = navigator.geolocation.watchPosition(onSuccess, onError, options);
    }

    // onSuccess Geolocation
    //
    function onSuccess(position) {
        var element = document.getElementById('geolocation');
        element.innerHTML = 'Latitude: '  + position.coords.latitude      + '<br />' +
                            'Longitude: ' + position.coords.longitude     + '<br />' +
                            '<hr />'      + element.innerHTML;

        var myFirebaseRef = "https://myperaktransit.firebaseio.com/";
        var myDataRef = new Firebase(myFirebaseRef);
        myDataRef.update({latitude : position.coords.latitude, longitude : position.coords.longitude});
        }

    // onError Callback receives a PositionError object
    function onError(error) {
        alert('code: '    + error.code    + '\n' +
        'message: ' + error.message + '\n');
        }

    //function updateFirebase()
    //{
    //  var myFirebaseRef = "https://myperaktransit.firebaseio.com";
    //  var myDataRef = new Firebase(myFirebaseRef);
    //  myDataRef.set({ latitude: '111', longitude: '222' });
    //  alert("Update successful");
    //}
    </script>
</head>
```

Figure 22: *Snippet of the HTML file to obtain the current coordinates of the bus*

CHAPTER 6 Conclusion

6.1 Achievements

Referring to Section 1.3.2, all unique objectives of this project have been met successfully.

Objective 1: To design and develop tracking system algorithm using GPS to track the real-time location of Perak Transit buses

The tracking system is developed using HTML and utilizing GPS technology embedded in most smart phones in order to save costs from implementing external tracking device.

Figure 23: The implementation of real-time bus location using GPS. The application tracks the bus' coordinates as it moves.

Objective 2: To design and develop a mobile application that enable users to track the real-time location of Perak Transit buses and its ETA at a particular stop.

The development of the mobile application is done using cross-platform technology such as PhoneGap, in which the framework development tool uses Web technologies. The developed mobile application is tested with five

users and has received generally positive reviews in the aspects of navigation and usability.

Objective 3: To evaluate the effectiveness of the prototype developed based on the outcomes from the users of Perak Transit buses.

The effectiveness of myPerakTransit prototype is performed after the development of the initial GUI based on the previous research findings as stated in Ismail et al. (2012), Ambak et al. (2009) and Anable (2005). The workings of the effectiveness evaluation can be observed as in Section 3.4.1 in Chapter 3 (Research Development & Methodology). The results attained are analyzed and documented in Section 4.2.1 in Chapter 4 (Results & Discussion). After the development of the mobile application, the product is then put through a user testing and the results are discussed in Section 4.4.1.

6.2 Suggested Works for Continuation

Initial result from the user testing of the mobile application shows a positive response in terms of the navigation and its usability. The initial idea of the project has also received generally positive feedback in terms of its impacts in helping to solve a social problem which involves the issues of efficiency, productivity, mobility as well as safety. Hence, this provides further strong justification for the need of the project. Due to some limitations, the project serves as a proof of concept towards the tracking technology to track the real-time location of the buses. The mobile application developed is proven to be working in its testing phase with few testing respondents and samples. This shows that the product can be implemented in the real working environment (the operation of Perak Transit buses).

The initial scope of the project primarily focuses on bus services of one line which is Route 47/471. Future works could include expansion of the tracking system over all Perak Transit buses for the betterment of the society who rely heavily on public transportation.

The ETA calculation provided could be improved by utilizing Maps for Google API in order to provide a rather accurate estimation and timing to the users to enhance the value provided by the mobile application towards the users of Perak Transit bus services. Furthermore, the mobile application may be developed on different platforms to give the application a reach on a wider audience and market.

All in all, the author has learnt throughout the whole phase of the project commencement that technology is a powerful and beneficial tool to help solve social problems in which the idea later can be transformed into a social venture of potential start-ups.

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APPENDIX

Appendix 1

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User Testing Feedback Form

FINAL YEAR PROJECT 2 - TCB4014

Wan Afifi Zawawie bin Wan Zakaria

FOR USE IN TCB4014 ONLY

Under the supervision of:

Dr Noreen Izza binti Arshad

(Department of Computer & Information Sciences,
Universiti Teknologi PETRONAS)

Correspondent's name:

Occupation:

Age:

Accuracy		**Answer**
1.	What is the suggestion of the arrival time of the bus?	
2.	What is the actual time that the bus arrived at the stop?	
3.	Is there any deviation in the information provided by the mobile application? If so, please state the difference	
4.	Do you mind about the deviation of the information provided? (Yes or No)	
Overall rating for this section (1 being lowest; 5 being highest)		
Navigation		**Answer**
1.	How many clicks of button do you have to perform before obtaining the desired information?	
2.	Is it easy for you to obtain the travelling information (bus distance from the bus stop, ETA, bus fares) when using the mobile application? (Yes or No)	
Overall rating for this section (1 being lowest; 5 being highest)		
Ease of Use		**Answer**
1.	Is the mobile application easy to use?(Yes or No)	
2.	How long does it take you to figure out how the mobile application works?	
3.	What is your feedback towards the mobile application? (1 being the very dissatisfied; 5 being very satisfied). You may also provide your written opinion.	
4.	Would you use the mobile application once it is commercialized? (Yes or No)	
5.	Would you recommend the mobile application to your friends and/or family members? (Yes or No)	
Overall rating for this section (1 being lowest; 5 being highest)		

END OF SURVEY

Appendix 2

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Survey (Questionnaire) Form)

FINAL YEAR PROJECT 1 – TCB3012

Wan Afifi Zawawie bin Wan Zakaria

FOR USE IN TCB3012 ONLY

Under the supervision of:

Dr Noreen Izza binti Arshad

(Department of Computer & Information Sciences,
Universiti Teknologi PETRONAS)

Correspondent's name:

Occupation:

Age:

1. How satisfied are you when you are using the public buses of Perak Transit in terms of convenience and service provided?

   ◯ Very satisfied

   ◯ Satisfied

   ◯ Average

   ◯ Dissatisfied

   ◯ Very dissatisfied

   Follow-up questions:

   1. How do you find the services up to this date?

   2. Explain briefly about the problems you normally faced when using Perak Transit services?

2. If a mobile application is to be developed to track the real-time location of the buses and provide ETA, would it be beneficial to you?

   ◯ Yes

   ◯ No

   ◯ Maybe

3. How do you find the functionality of the mobile apps to track the locations of the buses?

   ◯ Very useful

   ◯ Useful

   ◯ Not useful

4. How do you find the functionality of the mobile apps to provide estimation of time of arrival (ET) at a specific bus stop?

   ◯ Very useful

   ◯ Useful

   ◯ Not useful

5. How do you find the ability of the mobile apps to provide the users with the bus fares schedules?

   ◯ Very useful

   ◯ Useful

   ◯ Not useful

   Follow-up questions:

   1. Do you find that the information in Perak Transit's website sufficient?

   2. What sort information is missing in your opinion?

6. How do you find the ability of the mobile apps to provide the users with the bus driver's details should you there be a need to make a complaint or report?

   ◯ Very useful

   ◯ Useful

   ◯ Not useful

7. With the mentioned proposed functionalities of the mobile apps, do you think that the travelling experience can be enhanced through the use of this mobile apps?

   ◯ Yes

   ◯ No

   ◯ Maybe

END OF SURVEY